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Viticultural Investigations—Commonwealth Research Station, Merbein.

1. Introduction.

At the present time, Australia is the third most important country from the point of view of the production of dried vine fruits, and in addition is the largest supplier of such fruit to the markets of Great Britain. Her annual production now normally varies from 60,000 to 65,000 tons, this amount corresponding to a total return of over £2,000,000 per annum. It has been estimated that some 40,000 people are dependent on the industry, and that 7,000 of them are directly engaged in production, either as growers or employees.

Of the total Australian production, it is necessary to export approximately 80 per cent., or roughly 50,000 tons per annum. The export trade is thus of outstanding importance to the Australian grower. Even in the early days of the industry, that is, immediately subsequent to the war, the competition in outside markets by such countries as the United States of America, Persia, Greece, Turkey, &c., was sufficiently strong to impress on the industry the urgent necessity for the use of efficient methods of growing the grapes, of drying, dipping, grading them, &c., and for the rapid improvement of such methods through scientific research. The present Commonwealth Research Station, Merbein, is largely the result of that realization. In fact, for a year or so the Station was financed entirely, and in subsequent years to a very considerable extent, by the industry.

2. Early History of Organization and Finance of Station.

At a large meeting of Mildura and neighbouring district growers which met on 1st December, 1917, the following resolution was unanimously agreed to :—

> "That a Committee of practical growers, with the Principal of the High School as Secretary and the agricultural representative as member, be appointed to inquire into the causes and treatment of black spot, and other vine diseases, with power to take such steps as they deem necessary to wipe out these diseases, and to authorize expenditure, if necessary, to the extent of 1s. per ton (dried weight) on the 1918 season vine fruits—such fee to be collected from the packing houses on the 1st of May, 1918, and if not immediately needed, to be held in War Loan Bonds, as a future fighting fund in the interests of the dried fruits industry of Mildura and Merbein districts—and that the Committee take prompt steps to inquire into all available evidence, so that experiments may begin at once."

The Committee referred to in the resolution was formed immediately, and for some years it was known as the Mildura and District Research Committee. Late in 1920, however, it was replaced by the Vineyards Protection Board, which was a body that was legally constituted under the Mildura Vineyards Protection Act No. 2959 (Victoria) with power to rate vineyards up to 2s. 6d. per acre. The primary objects of the Board were (i) to police the entry of plants and fruit which could possibly introduce additional pests and diseases into the isolated settlement of Mildura, and (ii) to carry out research work.

At its first meeting, the above Research Committee appointed Mr. A. V. Lyon, then of the Mildura High School staff, to act as its investigator. Mr. Lyon has been in charge of the investigations ever since, and is now Officer in Charge of the Commonwealth Research Station, Merbein, where they are centred. The Victorian State Rivers and Water Supply Commission was immediately sympathetic to the objects of the Committee, and provided an area of some 60 acres free of rent for the purpose of the work. It also provided irrigation water free of cost for some years, and subsequently at half rate. Since 1932, all water rates have been remitted. At the time of the formation of the Research Committee, and for several years afterwards, a sum of £200 was also made available as rent from the Mildura High School " College lands."

In the year 1918, the above Committee approached the predecessor of the Council for Scientific and Industrial Research, namely, the Advisory Council of Science and Industry, with a request for financial assistance. As a result, it was eventually arranged that, as from the beginning of the year 1919, the Advisory Council would contribute on the basis of 10s. for every £1 subscribed locally up to a maximum subsidy of £750 per annum. This agreement was conditional among other things on the minimum average amount being subscribed by the vignerons being £1,000 per annum and on the results being made public by the Council so that all the States of the Commonwealth and not only one State might be benefited. The work proceeded on this basis for five years, and in 1924, the immediate predecessor of the Council and the successor of the Advisory Council, namely, the Institute of Science and Industry, published a Bulletin (No. 28) compiled by Mr. Lyon and entitled " Problems of the Viticultural Industry." This publication gave most of the results obtained to that date.

During the years 1925 and 1926, the Vineyards Protection Board received a grant of £750 per annum from the Victorian Department of Agriculture. At that time too it began to derive a return of about £600 per annum from the sale of produce, all of which return was devoted to the experimental work. In 1926, however, realizing that with the growth of additional settlements, protection of one portion alone would be ineffective, and that it was inequitable to rate growers of the Mildura district only, when the work of the Station was of value to a much wider circle, the Board applied for a repeal of the Act under which it was constituted. Accordingly a new district, including all settlements producing dried fruits along the Murray River in the States of New South Wales and Victoria, was proclaimed, and the necessary inspectional work undertaken by the two States concerned.

Having previously assigned all its assets, including planted land, buildings and equipment of the Research Station, to the Council for Scientific and Industrial Research, the Vineyards Protection Board finally ceased to function in 1930 on the repeal of its Act by the Victorian Government.

3. Subsequent Organization and Finance.

In anticipation of the cessation of its activities, the Mildura Vineyards Protection Board suggested in 1927 that the Council for Scientific and Industrial Research should take over the Station. This was arranged shortly after, and since 1927 the Station has been controlled and financed by the Council. The load, however, has been considerably lightened by the previously mentioned co-operation of the Victorian State Rivers and Water Supply Commission, by the Australian Dried Fruits Control Board, which in 1930 agreed to contribute £1,000 per annum for two years, and by the assistance afforded in funds and service by a number of growers' organizations scattered throughout the whole of the irrigation districts along the Murray River.

Subsequent to the taking over of the Station by the Council, it was considered that the work would be helped if the advice and assistance of the Divisions of Soils and of Plant Industry could be made available at all times, and if these bodies assisted in the initiation and conduct of those experiments at the Station which lay in their special fields. Such a condition of affairs has now been brought about through a Committee of Control which has been set up in connexion with the work of the Station, and of which the present personnel is :—

Dr. B. T. Dickson, Chief, Division of Plant Industry.

Professor J. A. Prescott, Chief, Division of Soil Research.

F. K. Watson, Esq., Water Conservation and Irrigation Commission, Griffith, New South Wales.

In addition, an Advisory Committee, consisting of representatives of the State Rivers and Water Supply Commission, of packers, and of local growers, has been set up in order to secure close co-operation between the Council and the respective bodies, and also in order to maintain local interest in the investigations. The present personnel of this Committee is :—

D. C. Winterbottom, Esq., Mildura Packers Association (*Chairman*).

S. P. Bromfield, Esq., State Rivers and Water Supply Commission, Victoria.

F. K. Watson, Esq., Water Conservation and Irrigation Commission, New South Wales.

A. Lever, Esq., Merbein fruitgrowers.

J. A. Lochhead, Esq., Mildura fruitgrowers.

A. E. Cameron, Esq., Red Cliffs fruitgrowers.

A. V. Lyon, Esq., Commonwealth Research Station, Merbein.

Periodically, the Advisory Committee meets a similar body of the Commonwealth Research Station, Griffith, New South Wales, in joint conference at either Merbein or Griffith for discussion of the investigations being carried out at both Stations and to raise any additional problems that may be considered as urgently requiring solution. State and Commonwealth officers engaged on similar work attend these joint meetings when opportunity is afforded to discuss the status and plans of related investigations, and to see the work of the Station at which the meeting is held.

4. Lay-out and Staff of the Station.

(i) *Lay-out.*—The Station is situated in the southern portion of the Merbein settlement, on the Murray Valley highway from Mildura to Adelaide. It is 4 miles from the Merbein township and 9 from Mildura. The land is of relatively low quality, and for this reason was originally excised from the soldier settlement blocks. It is Crown land, vested in Trustees appointed by the State Rivers and Water Supply Commission.

Prior to planting the area, a map of the original vegetation distribution was prepared, and this has served as a useful guide to soil conditions pending a more complete soil survey of the Station. There was a good natural slope for irrigation purposes, and no preliminary contouring or grading was necessary for laying out the plots. No special surface drainage is installed, but underground drainage to the extent of two timbered shafts each 4 feet by 2 feet in section, 60 feet or more deep, and penetrating to the porous layers have been provided. From these shafts, drives have been put out into the porous layers to a distance of 10 feet.

At the present time, and exclusive of the newly-planted salt field, about 16 acres are planted approximately as follows :—

8 acres Sultanas, 6 acres Zante Currants, 1 acre Gordo Blanco, and 1 acre Miscellaneous, including phylloxera resistant stock.

During planting, the necessary provision was made for replications, standard checks, and buffer rows of vines to overcome the overlapping influence of adjacent plots. Irrigation water enters at the north-east corner after being pumped from the river for the whole settlement. Whilst the farm was designed for investigational work, it has been developed as much as possible on commercial lines, and a good annual crop is now obtained.

During the last two years or so, another field of 17 acres has been planted in order to obtain accurate data regarding the salting of irrigation blocks—a problem which has become all too evident throughout closer settlements of the Murray. Before planting this field, it was botanically surveyed in the virgin state, and a survey of the original salt content of the soil was also carried out (see this *Journal*, **4** : 12, 1931). As a result, it was established that the distribution of salt both laterally and vertically was far from uniform.

The older vineyard is now being used for viticultural, irrigation, and drainage studies, while the newer portion is almost wholly reserved for the study of salt distribution in relation to the virgin state, and to changes consequent on irrigation, drainage, and the growth of vines and cover crops.

(ii) *Staff.*—As at present organized, the staff of the Station is as follows :—

(*a*) *Scientific*—

A. V. Lyon, M.Agr.Sc., Officer in Charge.
J. E. Thomas, B.Sc., B.Agr.Sc., B.V.Sc., Agricultural Officer.
D. V. Walters, B.Agr.Sc., Technical Assistant.

(*b*) *Other*—

J. E. Giles, General Assistant.
T. Corrie, Farm Foreman.
J. A. Kennedy, Farm Labourer.
Casual employees as required.

As will be seen from Section 6, however, it is hoped to augment this staff somewhat in the near future.

5. Work of the Station.

The main lines of investigations originally laid down in the days of the Mildura District Research Committee are still being followed up to-day, but naturally, as the work has progressed, other avenues of useful work have become apparent and other problems have also become urgent. The programme has thus grown considerably since the original fields were planted.

The present work of the Station may be discussed under the following headings :—

(i) *Fruit Processing.*—The work of the Station on the processing of dried fruits has proceeded for several years. The necessity for it arose through the original unsuitability of the Australian product for overseas markets. The caustic soda dip in former use resulted in dark coloured sultanas and raisins, whereas a light colour, similar to that of the products of the Levant, was favoured on the London market.

The investigation initially consisted of a study of Greek methods of cold dipping in a solution of potassium carbonate to which an olive oil emulsion is added, and the necessary modifications for shaded rack drying as practised in Australia as compared with exposure to the sun on trays, for which the Greek method is devised. A satisfactory procedure was evolved and recommended to growers.

The product from the " cold dip " proved satisfactory, but the slow drying rate, in relation to rack space, was found to be a disadvantage. With an improvement in prices in recent years, additional rack space is being provided by growers, and the present position is that the quantity of fruit cold dipped is steadily increasing, and the product on the whole is giving the best returns. The Australian Dried Fruits Association has recognized this fact, and is making provision to include the procedure for cold dipping in the standard recommendations.

The " mixed dip," designed to give a colour approaching that of the cold dip, but with a quicker drying rate, is now used for the major portion of the dried fruit in Australia. Over 90 per cent. of the fruit produced in South Australia is so treated. Compared with the cold dip, it is applicable to a greater range of conditions and diversity of seasons. The mixed dip was evolved at the Merbein Station, and as far as is known is used only in Australia. The experimental data on which the recommendations were based have not yet been published, being preceded by a pamphlet describing the preparations and their use. This pamphlet was prepared by Mr. A. V. Lyon and issued by the Australian Dried Fruits Association in 1932. The cold dip has been described in the Council's Pamphlet No. 6, issued in 1928.

(ii) *Irrigation Experiments.*—These are of two types—

(*a*) A study of the soil moisture changes occurring at Renmark and Merbein, and the " consumptive " capacity of the soil-plant group on representative soil types.

(*b*) A study of the method and frequency of application of irrigation water with respect to soil type. This work is also carried out at several settlements. A report containing suggestions for somewhat modified practices throughout the irrigation settlements has already been published as the Council's Pamphlet No. 26. Throughout these various settlements, the periodicity of irrigation is arranged by local advisory boards who thus have the power of saying when an irrigation will commence in

any district and roughly in what order the individual settlers will be watered. The method of irrigation of a particular block, however, is under the control of the block-holder. It has been established that in the past rather too much water has been applied to blocks, and also that the block-holders' methods of application have been unsatisfactory. Such conditions can often seriously damage the land by water-logging, sometimes associated with salting, resulting in whole or partial unproductivity of affected portions.

(iii) *Salting of Irrigated Soils.*—The work under this heading is mainly carried out in the new salt field already mentioned. It is fundamental and long dated, but it is designed to ascertain the conditions under which "salt" shows in a vineyard irrigated in the usual way, and also to obtain information on which preventative and remedial measures for salted blocks throughout the irrigated settlements as a whole may be based. The work is associated with the methods of irrigation, the rate, quantity, and frequency of application, and agricultural drainage in relation to soil profile.

(iv) *Viticultural Studies.*—Work of this nature has been carried out since the earliest days of the Station, and included an examination of the methods followed in establishing a vineyard in irrigated soils. This was of special importance during the development of the soldier settlements. Viticultural studies now include the following :—

(*a*) The methods of pruning so as to permit of a satisfactory quantity of fruit of good quality, and a balance of growth to ensure the potential crop for the following year. This study is carried out in relation to soil type and general environment, and embraces a comparison between potential and actual yield.

(*b*) A study of the balance of fruit and annual vegetative growth. This question is being reviewed, as results recently obtained by Winkler in California indicate an advantage in light pruning accompanied by bunch removal, a practice which gives an increase in foliage in relation to the number of bunches, in comparison with present methods by which bunches and foliage are removed proportionally in pruning.

(*c*) The extent to which yields may be influenced by shortening the shoots by "tipping" and "topping," practices which have been shown to influence bud development.

(*d*) The effect of disbudding in early spring of adventitious shoots on spur-bearing varieties. An influence on the quality of the fruit has been established, and the study has been extended to an investigation of the relation of the size of the bunch to the individual shoot on which it is borne.

(*e*) On very old vineyards where yields are unsatisfactory, the rehabilitation or reconditioning of the vines is being studied and the variability of yield noted with a view to determining methods by which yields may be increased and made more uniform.

(*f*) A study of some of the seasonal operations affecting the setting of fruit. The practices of "cincturing" and "topping" are known to influence setting, and the effects are being studied in detail. The results of sulphuring at flowering time are also being observed.

(v) *Botanical Studies—Roots and Bud Differentiation.*—A study of the normal feeding habits of the sultana has already been carried out and the results published*. The bud studies form part of a scheme of work in co-operation with the Division of Plant Industry whereby it is hoped to ascertain the relations between growth and fruit bud differentiation in order to be able to carry out manurial and pruning practices conducive to the best yield of best quality fruit. It is fundamental and long dated work. The results obtained to date were published last year† and show that the basal buds are differentiated by about the 12th November, whilst those of the sixteenth node are differentiated by the 11th December, that is, fifteen months and sixteen months respectively before the fruit corresponding to the buds is finally mature.

(vi) *Manurial Experiments.*—Work of this nature is carried out mainly on plots that have been established at Renmark and Red Cliffs. The plots have been laid out on the Latin square basis to determine the relative effects of no manure, superphosphate, ammonium sulphate, and superphosphate plus ammonium sulphate on growth and yield. This field is proving very useful in the development of the technique for yield measurement, which includes a record of the performances of the individual buds on fruiting wood.

6. Extension of Work to Other Districts.

A feature of the Station's work of recent years has been the ever increasing demand for the results of the Station's investigations and for the necessary testing work before they are applied to the local conditions of the other dried fruits settlements. As an example, the case of Woorinen might be quoted. In this district, maturity is from a week to ten days later than Mildura, and troubles thus arise owing to unsatisfactory climatic conditions at the end of the drying period. It is believed that the effects of this lag might be overcome by the adoption of slightly different cultural methods and by different irrigation methods whereby maturity is hastened. Experimental work on the matter, however, is needed, and plans for its initiation are now under consideration.

This work in other districts and the more rapid development of the investigations at the Station itself cannot be financed from the funds which the Council can provide, and the work must perforce wait until the necessary finance is forthcoming. Nevertheless, there is reason to hope that contributions will be forthcoming in the near future, and that it will thus be possible to make the necessary small addition to the present staff.

7. Co-operation with State Departments and Primary Producers' Organizations.

(i) *Processing of Dried Fruits.*—An important feature of all investigations involving recommendations to producers is the standardization of those

* This *Journal* **5**: 88, 1932.
† This *Journal* **5**: 97, 1932.

recommendations. For this phase of the work, the Council has, in co-operation with the other organizations concerned, formed the Interstate Fruit Processing Committee, the personnel of which is as follows :—

A. V. Lyon, Esq., M.Agr.Sc., Council for Scientific and Industrial Research (*Chairman*).

W. R. Jewell, Esq., M.Sc., F.I.C., Agricultural Research Chemist, Department of Agriculture, Victoria (*Secretary*).

Geo. Quinn, Esq., Chief Horticultural Instructor, Department of Agriculture, South Australia.

C. G. Savage, Esq., Director of Fruit Culture, Department of Agriculture, New South Wales.

F. de Castella, Esq., Viticulturist, Department of Agriculture, Victoria.

This Committee has arranged for the initiation of urgent investigations, by State and Commonwealth authorities, and for issue of joint recommendations to producers on a Commonwealth basis. The Committee recognizes that standardization of recommendations is a necessary prelude to standardization of the products on an Australian basis, and has already taken the necessary action in regard to dried grapes, apricots, peaches, and prunes.

(ii) *Irrigation Problems.*—A very close co-operation is maintained with the irrigation districts in Victoria, the Merbein Station being represented on the Local Advisory Boards for irrigation. Similar action is being taken in the principal Murray River Settlements in South Australia and New South Wales where the irrigation and agricultural officers of State Departments co-operate in both investigational and advisory work. There is a very general recognition of the importance of proceeding with investigations of irrigation problems, and it is recognized that economy and efficiency in water distribution are accompanied by better annual yields and preservation of the capital value of the land. The basis of co-operation in South Australia may be illustrated by a motion passed in August, 1932, at a special Conference at Berri, convened by the South Australian Director of Lands, when it was resolved—"That it be a recommendation from the Conference that the Council for Scientific and Industrial Research, the Agricultural Department, and the Department of Lands (of South Australia) confer regarding improved methods of irrigation and the establishment of investigational and demonstrational plots on the more difficult soil types of the various irrigation areas."

The suggested action has been taken, and the investigations were commenced on a co-operative basis in January, 1933.

(iii) *Non-Irrigated Vines in South Australia.*—Action to initiate investigations was taken by the State Dried Fruits Board of South Australia, it being recognized that both yield and quality of fruit were unsatisfactory in these areas. Investigational plots have been established, and a supervising Committee appointed by the State Board. The Committee consists of the following members :—

J. Victorsen, Esq., South Australian Dried Fruit Board.

W. N. Twiss, Esq., South Australian Dried Fruit Board (*Secretary*).

A. V. Lyon, Esq., Council for Scientific and Industrial Research.

Geo. Quinn, Esq., Department of Agriculture, South Australia (*ex officio*).

The investigations are carried out by the Department of Agriculture assisted, as opportunity offers, by members of the staff of the Merbein Station. A very pleasing feature of this movement is the co-operation of the settlers, who have formed local committees to assist in carrying out the investigations and in supplying funds for the work on the plots.

(iv) *The Nyah-Woorinen Research Committee.*—Growers in the settlements of Nyah and Woorinen have been largely responsible for the establishment of this Committee, the personnel of which includes representatives of C.S.I.R., the Victorian Department of Agriculture, the Victorian State Rivers and Water Supply Commission, and the settlers. With the assistance of the Committee, irrigation investigations are carried out conjointly by the Council (C.S.I.R.) and the Victorian Department of Agriculture, and the viticultural investigations by the Council.

(v) *General.*—The four principal co-operative efforts in which the Merbein Station is concerned have been cited above. An important feature is the provision to prevent overlapping of investigations and the opportunity for contact for officers engaged on similar work.

8. Economic Value of the Station's Work.

The assessment of the value of the Station's investigations is difficult owing to changing conditions of markets and world conditions. There is no doubt, however, that it is very considerable and that it represents an acceptable national dividend. An indication of the financial value of the whole co-operative efforts of those concerned may be obtained from the following paragraphs which briefly summarize the more outstanding results that have been obtained :—

(i) Since the commencement of work twenty years ago, the average yield of dried fruits per acre has doubled.

(ii) A successful export trade has been established, the quality of the dried fruit being so improved that successful competition with other countries in the principal world's markets is being maintained.

(iii) The cash value of the improvement in quality of the dried product, in comparison with that obtained by former methods, is obtainable for the transition period. Thus, in 1930, of the total pack of 73,000 tons, over 40,000 tons were processed by improved methods evolved at the Station. Trade returns showed an increased value in competitive markets at the same period, of over £5 per ton, of fruit treated with improved methods as compared with former methods. Thus the improved methods returned in the one year an advance of £200,000 to the industry. Since then, the improvement in quality has been maintained, and the newer methods have extended to additional districts.

(iv) The annual rateable value of the water supplied in the Mildura district alone is now approximately £100,000 per annum. Decreased costs in supplying this water, accompanied by more efficient production of dried fruits and a decided slackening in the rate of depreciation of the irrigated lands, are features of the operations of recent years.

Further Observations on the Association of Mallee Scrub with Frosts.

By E. S. West, B.Sc., M.S.*

Summary.

Data obtained since the mallee scrub has been cleared on the Murrumbidgee Irrigation Areas confirm the conclusion of a previous report that mallee scrub causes lower temperatures to be experienced on calm, clear nights in and near the scrub, than in open country.

1. Introduction.

At two localities on the Murrumbidgee Irrigation Areas, one in the Yenda district and one in the northern portion of the Lake View district, unusually severe frosts have caused considerable damage from time to time. So serious have been these frosts that at Yenda, plantings of citrus have been replanted to other varieties, while at Lake View the area was abandoned altogether for horticultural purposes, and the few men who had endeavoured to establish orchards there sought farms in more favoured localities.

The proximity of uncleared mallee scrub at both localities suggested the possibility that this may in some way be the cause of the unusual frosts experienced. Observations made by exposing minimum thermometers within the mallee, near the mallee, and some distance from the mallee, showed that consistently, and regardless of the surface contours, the minimum temperatures on calm, clear nights became lower as the mallee scrub was approached. Observations were made on four distinct, widely separated belts of mallee, and on several sides of each belt, with the same results.

These results were summarized in a previous paper,† in which it was concluded that mallee scrub had an important influence in causing severe frosts. Since that time, some of the mallee in which these investigations were carried out has been cleared, and an opportunity was thus afforded of confirming, or otherwise, the conclusions previously drawn, by observing the effect of the removal of the scrub on the minimum temperatures.

2. Field Observations.

After portion of the mallee had been cleared, thermometers were set up in eighteen positions in which minimum temperaures had previously been recorded, sites being selected where the scrub still remained, where it had recently been cleared, and where none of it occurred. It was found that where the mallee still remained, the minimum temperatures were lower than in the open country, but where it had been cleared, the minimum temperatures were higher, relatively, than they had been before the mallee was cleared, and were now similar to those in the originally open country.

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† This *Journal* **4**: 173–177, 1931.

A further confirmation is obtained from the data yielded by minimum thermometers exposed in certain localities throughout the winters of 1930, 1931, and 1932, which were read regularly throughout the winters. The following table summarizes some of the results which were obtained:—

Station.	Remarks.	Mean Minimum Temperatures on Clear Nights. (In deg. Fah.)		
		1930.	1931.	1932.
Research Station ..	10 miles from mallee	30·0	30·0	30·0
Farm 1985 ..	Near mallee, Lake View, mallee cleared 1931–1932	24·5	25·2	27·7
Farm 1494 ..	Near mallee, Yenda, mallee cleared after 1930 readings	26·2	28·6	28·7
Farm 1822 ..	3 miles from mallee, Lake View ..	27·1	27·8	27·5
Farm 1325 ..	2 miles from mallee, Yenda ..	..	27·8	27·5
Farm 1589 ..	3 miles from mallee, Lake View ..	28·9	..	28·3

To obtain the mean minimum temperatures, the mean difference between the minimum temperatures recorded at the station under consideration and at the Research Station was found, and the relative mean minimum temperature then calculated, taking the minimum temperature at the Research Station as 30.0° F. as a standard. Only readings on calm clear nights were used.

3. Discussion of Results.

The relative minimum temperatures of stations, other than those of farms 1985 and 1494, were approximately the same each year. In fact, this was also the case for other thermometer stations from which similar temperature data are available, but which are not included in the above table. Appropriate precautions were taken, of course, to expose the thermometers under reproducible and similar conditions each year.

Farm 1985 is about 20 acres in extent, and during the 1930 winter was completely surrounded by uncleared mallee scrub. Some of this was cleared before the 1931 readings were taken, leaving uncleared mallee scrub on one side of the farm. Before 1932, a further area was cleared, and bush fires killed the rest, leaving only dead timber devoid of leaves. It is seen that the relative minimum temperatures became progressively higher as more of the mallee scrub was cleared. During the 1932 winter, when the scrub that remained had been more or less destroyed by bush fires, so that its influence was probably negligible, the minimum temperatures were similar to those in other localities similarly situated, such as the stations at farms 1822 and 1589, situated at Lake View, and farm 1325, situated at Yenda, which farms are several miles from any scrub.

Mallee scrub existed adjacent to farm 1494 prior to and during the 1930 winter, but was cleared before the 1931 winter. It is seen that in this case, also, the relative minimum temperatures were increased after clearing the mallee scrub, so that they are now similar to those experienced in other similarly situated localities.

The clearing of the scrub had a greater influence on the station at farm 1985 than at farm 1494, and this is what was to be expected, as farm 1494 was adjacent to about 100 acres of scrub only, while in the case of farm 1985, the scrub was a few thousand acres in extent, and, moreover, it completely surrounded the farm.

The standard error of the mean differences between any other thermometer station and that at the Research Station is 0.3 to 0.4, so that the differences observed, due to clearing, being from 7 to 9 times this standard error, are undoubtedly significant.

A large amount of data was collected which showed that these "standard" stations actually represented the conditions of the locality. Thus, for each station for each year, several other thermometers were exposed for several nights in the locality of the "standard" station, so that it is known that these "standard" stations represent the conditions obtaining throughout the localities they represent.

It may also be explained that the minimum temperatures at the Research Station represent average conditions on the Irrigation Areas, as made evident not only by extreme temperature observations, but also by long experience of severity of frost damage. Districts exist on the Areas where the degree of frost is usually less than that experienced at the Research Station, while, as is evident from the figures of the Table, both the Lake View district and the Yenda district, broadly speaking, have slightly more severe frosts than the general average. Besides these generalities, as are always found, small isolated areas in hollows experience more severe frosts than the general average of the locality, while on rises the frost is less severe. The effect of the mallee, both at Yenda and Lake View, was superimposed on these other conditions.

Since the mallee was cleared at Yenda, a definite improvement has occurred with regard to the amount of frost damage experienced. In the case of the Lake View locality, the clearing of the mallee has entirely altered the agricultural outlook of the locality. Prior to the clearing of the mallee, young citrus orchards were almost entirely wiped out with frost two years in succession, and the locality was abandoned for horticultural purposes. Since that time, two young citrus orchards have been established, and withstood the severe winter of 1932, which, from the point of view of frost, was as severe, if not more severe, than any other winter experienced since records have been taken at Griffith; and the locality is now considered suitable for horticultural purposes.

Apart from the evidence of the temperature readings, the changed conditions at Northern Lake View since the clearing of the mallee are quite apparent to those who are familiar with the locality. The severity of visible frosts, amount of injury to susceptible crops, freezing of taps, and other familiar manifestations of severe frosts, all tended to show that the locality was unusually subject to frost, but the conditions do not now appear abnormal.

A Possible Biological Control of the Clover Springtail or Lucerne Flea (*Sminthurus viridis* L.) in Western Australia.

By H. Womersley, F.E.S., A.L.S.

Mr. Womersley was appointed to the staff of the Council early in 1930. Prior to that, he had specialized on groups of minute insects in England, and before coming to Australia he spent some months as an officer of the Council examining—at the British Museum and elsewhere—those families of insects of which a knowledge would be helpful in connexion with work on the clover springtail and the red-legged earth mite which it was proposed he should investigate in Western Australia. After spending a short time in South Africa, in the hope of obtaining likely parasites, he reached Perth late in 1930, and was then afforded valuable assistance in the form of laboratory accommodation, &c., by the Western Australian Department of Agriculture and by the University of Western Australia. He resigned at the end of 1932 to take up the position of Entomologist to the Public Library, Museum, and Art Gallery of South Australia. The Board of Governors of that organization has agreed to the Council's suggestion that he be permitted to continue his work on the Bdellid mites of Australia. He will undertake work on this group as part of his routine duties at the museum.—[Ed.]

Summary.

1. In certain areas of Western Australia, a species of Bdellid mite, *Biscirus lapidarius* Kramer, possibly an introduction from Europe, has made its appearance in paddocks infested with the clover springtail (lucerne flea), *Sminthurus viridis* L.

2. Field observations extending over two years have shown that this mite is an active predator on *Sminthurus*, and reduces the population to negligible proportions within a comparatively short time.

3. Transportation to other areas has been partially successful and the areas have been cleared of *Sminthurus*.

4. As the breeding up of the mite in large numbers does not seem feasible, specimens can best be transferred from localities where active attack is proceeding.

5. The species, its immature stages, and partial life-history, are described and figured.

1. Introduction.

The paper that follows is an account of researches carried out in Western Australia during 1930-32 on the possibility of finding some natural agency for the control of the clover springtail or "lucerne flea" (*Sminthurus viridis* L.). The author was working under the auspices of the Commonwealth Council for Scientific and Industrial Research as an officer of the Division of Economic Entomology, and in conjunction with Mr. L. J. Newman, Government Entomologist of Western Australia. At the outset, therefore, he would like to express his appreciation of the valuable help that Mr. Newman, by his intimate knowledge of the pastoral conditions of the country, has been able to render, and especially also to thank Dr. R. J. Tillyard, Chief of the Division of Economic Entomology, at whose instigation he was engaged upon this problem, for much encouragement and advice.

The species of Collembola dealt with in this paper is perhaps one of the most important and difficult insect pests with which the State Entomologists of Australia have to contend. This is largely owing to the immense numbers in which it occurs in the paddocks, especially in those which have been laid down with subterranean clover.

According to available records it has been known in South Australia since 1884, and in Western Australia since 1914. It is largely influenced by the rainfall, occurring only where this exceeds 16 inches per annum. Further, because of the habit of soil ingestion by the newly hatched nymphs and also by the adult females prior to oviposition, it is rarely found inhabiting sandy country.

In addition to this species, several other species of the order are now known to occur in various parts of Australia in such numbers as to constitute potential pests at least. Some of these are probably introductions, but others are indigenous and have undoubtedly increased in numbers as more and more of the country has been brought under pasturage. From the aspect of biological control, however, we can consider all these species at the same time as *S. viridis.*

2. Review of Biotic Balance in Collembola.

Economically, because of the large acreages usually infested and the astounding numbers of Collembola present—rough estimates have given at least 60,000,000 per acre—cultural and spraying methods of control, while partially successful, are rather of the nature of palliatives, and are in any case costly. On the other hand, the possibility of biological control is reduced by the fact that—in spite of intensive search—parasites of Collembola, either of the eggs or adults, are quite unknown. The only hope of permanent control would seem, therefore, to lie in the discovery of suitable predators.

Many insects and spiders are known which are, to some extent, devourers of Collembola. In 1927, Holdaway recorded the Staphylinid beetle *Paederus singulatus* MacL. and an ant, *Pheidole ampla* For. as attacking *Sminthurus viridis* L., while in 1932 MacLagan listed two species of Coccinellidae, 7 of Staphylinidae, 1 Carabid, and 1 Telephorid among the Coleoptera, 1 Anthocorid, and 1 Capsid in the Hemiptera, and also the common European earwig *Forficula auricularia,* as more or less efficient predators. The same author also gave a list of eleven species of spiders as active feeders on *Sminthurus.*

Outside of these two groups, there is no evidence of Collembola being attacked by any of the Arthropoda except a statement in Lubbock's "Monograph on the Collembola and Thysanura," in which, speaking of *Sminthurus viridis* L., he says "It is sometimes attacked by a small red mite." This is, of course, a very vague statement, but, having worked at the Acarina for some years, the writer is of the opinion that the mite in question was probably the larval form of a species of Erythraeidae or Trombidiidae, the young of which are well known to attach themselves to, and feed upon, a large variety of insects.

In considering MacLagan's work, it must first be noted that he has assessed the value of the predators listed solely on the results of laboratory tests in small vials. In appraising the value of such predators in the field, too much importance must not be attached to results so obtained. His minimum value for what he termed a "good predator" was 1.4 *Sminthurus* eaten per day for not fewer than 35 days in

captivity. The maximum figure for this class was 6.0 for *F. auricularia.* This insect, however, as MacLagan himself pointed out, cannot be considered as a possible control, as it is liable to become a pest itself. For what he termed a "fairly good predator," he obtained a value of 7.7—for the beetle *Philonthus laminatus* Creutz—on the basis of a consumption of not fewer than 60 eaten during captivity irrespective of time. By his original criterion, and leaving out the case of *F. auricularia,* we find a maximum value of 5.0 for the Capsid bug, *Lygus pratensis,* and for the total listed, an average of only 2.8. With the spiders, the results are much the same, the maximum value being 2.4 for a species of *Erigone,* with an average of 1.6 for all species.

From the point of view of biological control, it can hardly be seriously contended that values such as these, even if borne out by field observations, offer any prospect of reducing the population of *Sminthurus* in such heavily infested areas as occur in Australia. From the writer's observations in England and in Australia, there is little evidence of effective control by any of the insects or spiders mentioned by MacLagan. Further, his data are not supported by any evidence of relative predator and *Sminthurus* populations. One must have such information, if only from general field observations, before it can be said that a certain predator exerts a control. In England, the *Sminthurus* population is only a fraction of that occurring in Western Australia, and, as in the former country it is scarcely considered to be a pest, it must be concluded that a biotic balance has probably been reached there.

3. Position in Western Australia.

In the study of this problem in Western Australia, it was soon realized that, almost everywhere where the pest occurred, the population was so dense as to preclude the presence of any satisfactory biological control. Even in such localities, however, many predators, such as those listed by MacLagan, were to be found in large numbers. Especially so were various spiders, but even these did not show any sign of control of the Sminthurids. In surveying the extent of the pest, it was obvious that the only chance of finding a suitable agent of biological control must lie in localities where, for some reason or other, the pest had died out or showed signs of doing so.

(i) *Discovery of a Predator.*—Early in May, 1931, observations were made in a paddock at Waroona which was stated to have been badly infested in previous years, but which was then scarcely affected. On examination, it was found that very few *Sminthurus* were present, but that large numbers of a small red mite belonging to the family Bdellidae (snout mites) could be obtained. Further, these mites were observed to be actively feeding upon the Collembola.

(ii) *Identification of the Predator.*—This mite is a species of Bdellidae and was provisionally identified as *Biscirus lapidarius* Kramer, which is a species well known from Europe. This identification was later confirmed by Dr. Sig Thor, the eminent authority of this group of Bdellidae. The actual recognition of the various species of Bdellidae is a very difficult and technical matter; but, in a subsequent paper, the writer proposes to give details of all species known to occur in Australia, together with keys for their separation. A full description of *B. lapidarius* in its various stages will be found in the Appendix (page 89).

4. Field Observations.

(i) *At Waroona.*—As already mentioned, the predatory mite was first observed at Waroona about 70 miles south of Perth, in May, 1931. According to information obtained from the owner, the paddock in which it was first found had been very badly infested with *Sminthurus* in previous years, but was practically free at the time of advice. The author was able to confirm its freedom at the time of his visit. It was, however, noticed that the paddock also contained a large number of Bdellid mites, some of which were actually feeding upon *Sminthurus.* It was therefore decided to keep this paddock under continuous observation, while specimens of the mite were taken back to Perth for identification and further study. In the meantime a very full inspection of the surrounding country was made and, although many paddocks were found to be very badly attacked by *Sminthurus,* in none of them were any Bdellids found.

On 12th May the paddock was again visited, the weather being very cold and showery. This time, very few *Sminthurus* were to be found, but the mites could be obtained in numbers by searching at the roots of the clovers. Seventeen days later, *Sminthurus* was practically non-existent, although the mites were still plentiful. On this visit, the adjoining paddock was examined and found to be badly attacked by *S. viridis,* but no mites could be found.

On 10th July both of these paddocks were found to be practically free of *Sminthurus* and to contain small numbers of Bdellids. On this occasion, the next paddock again (the third), previously heavily infested by *Sminthurus,* was found to have been invaded by the mite, although no visible diminution in the *Sminthurus* population could be noticed. The mites were also found to have reached the corner of the fourth paddock.

On 7th August the density of the pest in the third paddock was measurably reduced, and the Bdellids had advanced some distance further into the fourth paddock.

On 25th September the mite was still progressing, although more slowly, probably due to the approach of the dry season.

In the following season, these paddocks were first visited on 27th April, when the conditions in the first three were found to be as at the close of the previous season, that is, the Bdellids in fair numbers but *Sminthurus* few. In the fourth paddock, the mite had spread further and there was a very definite line of attack, in which the Bdellids were most abundant. In front of this line no mites were to be found, while the *Sminthurus* population was very heavy. Behind it, the *Sminthurus* had been considerably reduced.

By 3rd June the ground had been practically cleared of the pest as far as about half way across the fourth paddock. A last visit was made on 4th November, when, with the exception of about the last quarter of the fourth paddock, the *Sminthurus* population was no longer of economic importance. During the period of observation, the total area cleared in this locality was approximately 65 acres.

(ii) *At Denmark.*—Late in September, 1931, it was found that the same species of mite had appeared in a badly-infested paddock at Denmark. This particular paddock had been inspected in the previous year, but no sign of any control could then be discovered.

By 21st October this paddock was well populated with *Biscirus*, and the numbers of *Sminthurus* had considerably declined. The crop was, however, being cut and stacked as ensilage some distance away. At the foot of the stack, it was found that the Bdellids were becoming concentrated in large numbers.

On 5th July, 1932, when this paddock was again examined, it was found practically free of *Sminthurus*, but by close examination, a few mites were discovered at the clover roots. On inquiry, it was ascertained that the ensilage had been carted since the last visit to a spot about half a mile away and adjoining another heavily infested paddock. During the previous year, this had also been found free of any Bdellid or other control. On this latter occasion, however, it was found that the mites had reached it, evidently from the ensilage placed close by, for they were in large numbers in the corner nearest to it. There was, however, no apparent reduction in the *Sminthurus* population, but no fewer than 20-30 Bdellids could be taken in one sweep of the net.

These paddocks were again visited, in company with Dr. R. J. Tillyard, on 28th September, 1932, when the first was found to be still free of *Sminthurus*, while in the second the Bdellids had spread considerably, both within the paddock and to surrounding areas. The numbers of *Sminthurus* were also being very definitely reduced.

(iii) *At Other Places.*—In several places, notably Burekup and Cannington, similar conditions have been found to exist, and from all such places the farmers report the pest as now being of no importance. Wherever the *Sminthurus* population is found to be very large or on the increase, no Bdellids are present, except odd specimens of species other than *B. lapidarius*.

5. Attempts at Spreading Predator.

Owing to the difficulties attending the breeding up of these predatory mites in large numbers, attention was concentrated on spreading in the field. Specimens were best and most easily collected in sufficient numbers by examining the bits of curly bark that had fallen from the trees in the paddocks. These form ideal sheltering places, and the mites can generally be found under them in large numbers. Local spreading of the creatures will probably be accomplished best by transferring these pieces of bark, with the mites attached to them, where required. Although transportation over long distances has not yet been attempted, the scrapings from the base of an ensilage stack are suggested as a suitable medium.

Late in the season of 1931, about a dozen specimens of *B. lapidarius* from Waroona were liberated in the paddock adjoining the Insectary at Perth. No *S. viridis* were present in this paddock, but it was heavily populated with another species, *Katianna ornata* Womersley. By the beginning of the next season, the mites had increased tremendously and could be collected in hundreds. At the same time, the *Katianna* had decreased and had actually become scarce. Later, the mites themselves, as their food supply became scanty, also decreased within the paddock, but they were found to have migrated to surrounding areas.

Three attempts were made to introduce the Bdellid into a badly infested paddock at Guildford. The first two attempts were apparently unsuccessful but the third, made towards the end of the 1932 season,

was more promising. A month or two after liberation, out of 50 specimens liberated no fewer than 25 were recovered, although no reduction of the *Sminthurus* population was then apparent. The success or otherwise of this experiment will be assessable during the next season.

Introductions were also made at Muresk Agricultural College and at the State Farm at Denmark. All these introductions were made on locations where previous search had failed to show the presence of any Bdellids. This next season should show the results of these experiments.

6. Biology of *Biscirus lapidarius.*

Time has not permitted a very full study of this mite to be made, but the following details of its life-history have been determined.

The eggs are laid on the ground or on the decayed plant fibres lying on the ground. Owing to their coloration and small size, they are very difficult to find in the field. The duration of the egg stage has not been ascertained. It is probable that aestivation takes place.

The larval stage is probably a very short one, for only rarely does one find larvae in the field.

An interesting feature of this mite is that at certain periods it exhibits a partial gregariousness, specimens of all sizes collecting together under any bits of bark or similar material lying about. Frequently, they are to be found under the webs of spiders or Psocids. During this phase, they lie dormant, either preceding, or after passing through, an ecdysis. The period of dormancy may last for several days. The resting mites are rather lighter in colour, as compared with the active ones, and their legs and palpi are entirely white, in marked contrast to the body colour.

The adults are voracious feeders on various small Collembola, but show a very decided preference for *Sminthurus viridis.* They have also been observed to attack Psocids and other small insects. The prey is stabbed by the mite with its mandibles, generally in the neck or ventral region. In attack, it has been noted that the mandibles work alternately in the process of piercing the victim. Once the mandibles have been inserted, the victim is sucked dry.

Preference is shown for the nymphs of *Sminthurus,* although adults are also largely eaten. The mite does not, however, seem to be able to impale the adults quite as successfully as it does the nymphs, probably because of their greater agility.

The nymphs are easily captured, and in preliminary experiments it has been found that a single *Biscirus* devoured 18 nymphs in 24 hours on three successive days. This was the total number of nymphs available each day, but without doubt had more been supplied they would have been devoured.

7. Conclusion.

In concluding this preliminary account, it may be remarked that this is the first example of the use of any member of the Acarina for biological control. Acarina, and arachnids also, providing suitable species can be found, possess a great advantage over the majority of insect

predators, in that feeding takes place throughout their life, whereas other insect predators usually have a pupal or other resting stage. On the other hand, they are generally anything but specific in their food requirements. Species suitable for biological control, if not specific in their food, should be largely so, and be capable of feeding upon other material only during times of shortage of their normal diet. This will permit the retention of a nucleus should a recrudescence of a pest occur, after it has once been cleaned up. The species *Biscirus lapidarius* appears to meet these requirements. On occasions it has been seen to tackle various small Collembola as well as Psocids, which are always to be found in the paddocks.

In Western Australia, many other species of Bdellidae are now known to occur; all of these are predatory and have been observed to attack *Sminthurus* and other Collembola. Nowhere, however, have they been found in the numbers sufficient to suggest that they are material controls. Nevertheless, it is possible that they may multiply sufficiently under suitable conditions. The possibility of biological control, not only by this group but also by other groups of predatory Acarina, might thus well repay careful study.

8. Literature Cited.

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Appendix.

Description of the Adults and Early Stages of Biscirus lapidarius Kramer.

(i) *Egg State.* (Fig. 12.)

The eggs are small, slightly elliptical, of a brownish colour, and covered with long, somewhat gelatinous, and clavate or spathulate spines. In general they are similar to those figured by Trägärdh for another species, *Molgus littoralis*. They measure 250 μ by 200 μ.

(ii) *Larval Stage.* (Figs. 8-11.)

This stage has not been previously described for this species of *Biscirus*. Probably the reason is that the duration of the larval stage is very short. On several occasions, however, the writer has met with the larvae and the following description can be given:—

Length 420 μ. Colour as in adults but a little lighter. Rostrum 100 μ long, with only 2 pairs of ventral hairs. Mandibles 100 μ long with two long hairs on each as in the adults. Three pairs of short, thick legs (Fig. 8); from a comparison of the positions of the legs, it would appear that the third pair of the adult is interpolated between the second and third pairs of the larva. Palpi short, 140 μ, ratio of lengths of segments II : III : IV : V = 50 : 17 : 17 : 48, hairs on these segments 1 : 1 : 3 : 7 respectively, apical setae of fifth segment 67 μ long and as in adults. Body setae differing from the adults only, in that the second row from the front has 2 instead of 4. Eyes 2 on each side, placed on a level with the base of the second pair of legs.

(iii) *Nymphal Stage.*

Except for the absence of the genital organs, the nymphs exhibit no essential difference from the adults.

(iv) *Adult Male and Female* (Figs. 1-7).

As the Australian material agrees entirely with the descriptions given by Dr Sig Thor, his description is translated here.

> "Form, colour, and cuticle as usual. Rostrum about 30 μ long; ventrally with 6 pairs of hairs. Mandibles with 2 long, well developed hairs; the distal hair quite in the middle (156 μ from the distal end of a 345 μ mandible), the proximal 110 μ from the distal hair; length of distal hair 120 μ, proximal 108 μ. The proportions of the segments of a 435 μ palp = I : II : III : IV : V = 24 μ : 180 μ : 43 μ : 48 μ : 154 μ. The second segment has 5 hairs, the fifth 8-10; the lengths of the apical setae are 125-170 μ. The dorsal organ on the thorax is very similar to that of *Biscirus intermedius* Sig Thor., but sometimes the front chitinous structure is absent, occasionally both; the fine subcutaneous line is generally very distinct; the 4 (2 pairs) sensory hairs with large basal pores are slightly longer. On the hind edge of the cephalothorax, on the line of separation from the abdomen, are 4 short stiff setae. The fine striations of the cuticle are sometimes circular, sometimes zig-zag and usually transverse. Legs thick with normal hairs. Length of animal 1100-1700 μ, breadth 600-800 μ."

No particulars have been given previously of the differences in the sexes. In the adult stage, however, it is not difficult to distinguish them by the genital organs. In general, these organs lie below and between a pair of lips situated a little behind the last pair of coxae. Beneath each lip can be faintly seen three more or less circular discs, which in our species are smaller than those figured by Oudemans for *Molgus*. In the female, at the anterior end of the opening, is an exsertile organ of the nature of an ovipositor (Fig. 6*a-b*). In *B. lapidarius*, this organ is furnished apically with a short chitinous rod. The writer has not been able to detect this rod in any other species which he has examined, nor as far as he is aware has it been figured. It is always easy to see, in *B. lapidarius*, whether the ovipositor be exserted or not.

In the male sex, the most striking feature of the genital organ is a pair of posterior, recurved, granular, lobed organs which Oudemans terms "titillating organs" (Fig. 7).

EXPLANATION OF PLATE.

Biscirus lapidarius Kramer.

FIG. 1.—Dorsal view of entire animal.

FIG. 2.—Palp of adult.

FIG. 3.—Mandible of adult (*a*), entire (*b*) jaws.

FIG. 4.—Tibia and tarsus of adult.

FIG. 5.—A dorsal seta of adult.

FIG. 6.—Female genital organ, (*a*) ovipositor withdrawn, (*b*) exserted.

FIG. 7.—Male genital organ, t = titillating organ.

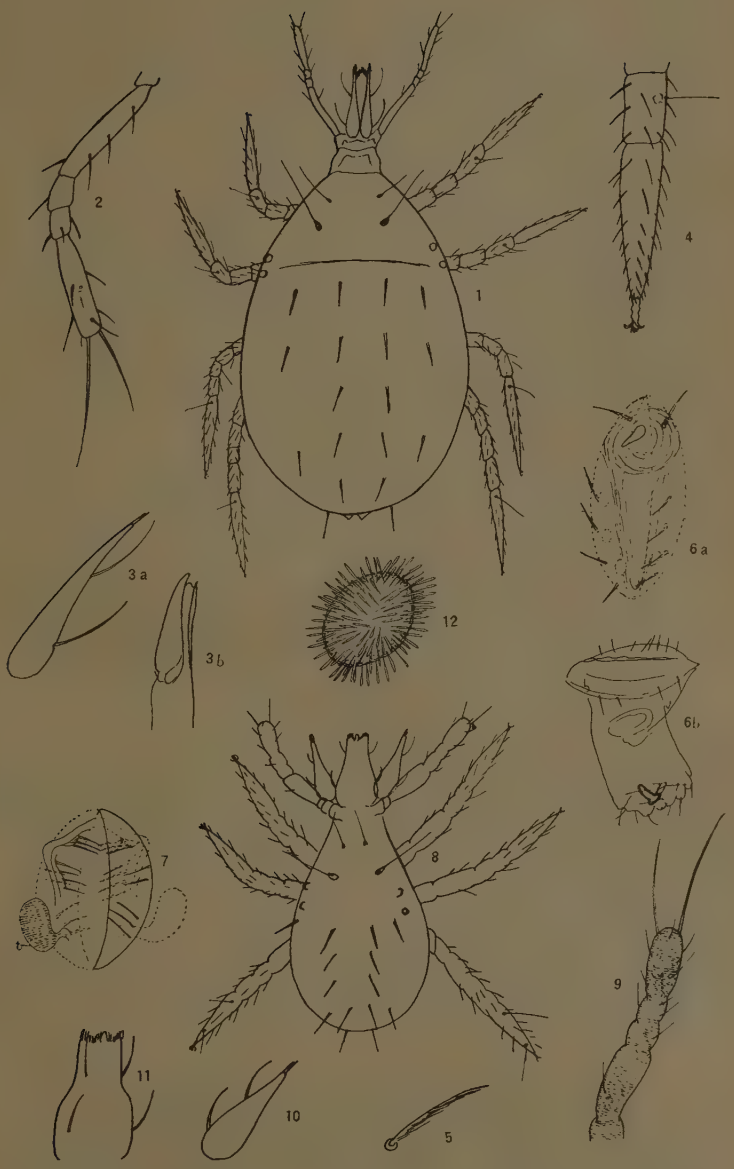
FIG. 8.—Larva, dorsal view.

FIG. 9.—Palp of larva.

FIG. 10.—Mandible of larva.

FIG. 11.—Rostrum of larva, ventral view.

FIG. 12.—Egg.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The Active Immunization of Sheep against Infectious Entero-toxaemia (Braxy-like Disease) by means of *B. ovitoxicus* Anaculture.

By H. W. Bennetts, D.V.Sc.

The work described in the report that follows has been carried out under a co-operative arrangement entered into by the Council and the Western Australian Department of Agriculture. Briefly, this arrangement was that the Department seconded its Veterinary Pathologist, Dr. H. W. Bennetts, to the Council, and in addition made various laboratory and other facilities available for the investigations. As a result of the work, Dr. Bennetts has been able to show that entero-toxaemia, or the so-called braxy-like disease of sheep in Western Australia, is due to an organism which he has termed *Bacillus ovitoxicus*. Many of the results to date have been published in the Council's Bulletin 57 issued last year. At that time, indications had been obtained that vaccination would probably be a satisfactory way of controlling the disease in certain cases. The report that follows is confirmatory of those indications.—ED.

Summary.

(i) Sheep may be actively immunized against entero-toxaemia by means of *B. ovitoxicus* anaculture. Two inoculations with three weeks' interval are recommended.

During the 1931 and 1932 seasons, the mortality rate in controlled flocks was reduced by 85 per cent. as a result of inoculation.

(ii) A small experiment indicated that lambs fattened on shed peas during the summer months can be satisfactorily immunized by this method.

(iii) Lamb dysentery bacillus anaculture did not immunize guinea pigs against *B. oxitoxicus* toxin, although a response was obtained with *B. ovitoxicus* anaculture.

(iv) *B. ovitoxicus* "alum toxoid," tested on guinea pigs, did not possess any greater antigenic efficiency than *B. ovitoxicus* anaculture.

1. Introduction.

In a previous communication (Bennetts (1)), we have given a full account of the investigation of the etiology of infectious entero-toxaemia (braxy-like disease of sheep in Western Australia) as well as the result of prophylaxis with formalized antigens of the causal organism *B. ovitoxicus*. This preliminary laborabory and field work with anaculture, during 1929 and 1930, gave encouraging results.

The purpose of this article is to record the results obtained in the field, with anaculture, since the publication of this previous report, and to discuss experiments carried out in the laboratory with other types of antigens, including one prepared with the lamb dysentery bacillus, which was tried for reasons indicated.

2. Preparation of Vaccine—*B. ovitoxicus* Anaculture.

This has already been given in detail, and is briefly as follows:—

Bottles containing "horse muscle broth" with about 2 per cent. of meat are inoculated with breast muscle obtained aseptically from pigeons dying as a result of intramuscular inoculation with cultures of *B. ovitoxicus*. Glucose to a 0.1 per cent. concentration is then added and cultures are incubated at 37° C. Originally, a 24-hour period was

used, but it having been demonstrated that more toxic cultures were obtained with longer incubation, a 48-hour period was substituted for vaccines prepared for the 1932 season and subsequently.

The resultant cultures are filtered through muslin to remove meat particles, and 0.5 to 0.7 per cent. formalin is added (the toxin obtained from 48-hour old cultures is somewhat more refractory to the action of formalin and the higher concentration seems necessary). The formalized culture is incubated until a 10 cc. amount is no longer lethal to a guinea pig on intramuscular inoculation. This usually requires about fourteen days. The vaccine is then ready for use. Prior to the addition of formalin, a small amount of culture is removed for titration of toxin content.

During 1931 and 1932, vaccination has been carried out by veterinary officers of the Western Australian Department of Agriculture, and the previous routine of two inoculations at an interval of three weeks has been followed.

3. Field Results in 1931 Season.

From January to August, 1931, a total of 9,679 sheep on 21 properties were inoculated with *B. ovitoxicus* anaculture prepared in the Perth laboratory. Throughout, only half of the various mobs were inoculated and branded distinctively, an approximately equal number of un-inoculated animals being run with them as controls. The dose used was 5 cc. followed by 10 cc., both inoculations being given subcutaneously. Young animals received correspondingly smaller doses of 2.5 cc. and 5 cc. No ill effects were noted except lameness, which frequently persisted for two or three days after inoculation. In two flocks, sheep were lame for more than a week. In some cases, on the occasion of the second inoculation, some of the sheep were seen to have a small indurated area at the site of the first inoculation. This appears to be a reaction to the dead bacteria injected, and may persist for several months.

As on previous occasions, the results were somewhat marred by the erratic incidence of the disease. Mortality due to entero-toxaemia occurred in only eight of the flocks where inoculation had been carried out, although the disease had recently occurred on all properties. Further, in these eight flocks, the death rate, with the one exception of 10.9 per cent., was low. The results are tabulated below.

(*a*) Vaccine prepared from R2, and M.R. Strains.

Owner.	Controls.			Vaccinated.		
	No. of Sheep.	Deaths.	Percentage of Deaths.	No. of Sheep.	Deaths.	Percentage of Deaths.
I.F.	286	12	4.2	286	0	0
S.B.R. ..	1,210	13	1.07	1,360	0	0
M. ..	3,100	117	3.77	1,867	17	0.91
W.	315	3	0.95	285	0	0
S.	143	2	1.4	143	0	0
W.B. ..	664	4	0.6	597	5	0.84
Whole Experiment ..	5,718	151	2.64	4,538	22	0.48

As a result of inoculation, there was a lowering of the mortality rate from 2.64 per 100 to 0.48 per 100; in other words, the mortality rate was reduced to only 18 per cent. of its former value.

Owner M. reported that the inoculated section of his flock had undoubtedly "done better" than the controls, and that the wool and progeny were also better. These claims were confirmed by personal inspection, but this apparent effect of vaccination has not been noted in any of the other flocks. Property M. is very highly improved, and the conditions obtaining are unusually favorable to the incidence of the disease. Following heavy losses in 1918 and 1919, the mortality rate declined, but the flock has never acquired the degree of natural immunity which is almost generally experienced, and for a number of years the average annual death rate from entero-toxaemia has been approximately 5 per cent. Field observations on this and on other properties suggest that a percentage of the flock develop mild attacks of the disease, which detrimentally affect the general health of the animals, although not giving rise to very definite symptoms. On a property such as M's, where conditions are so favorable to incidence, and where the disease has been enzootic for a long period, one would expect a rather large percentage of these cases. The beneficial effect of the vaccine, apart from its preventing mortality, may be due to the increased resistance following its use.

(*b*) Vaccine prepared from T2 Strain.

Owner.	Controls.			Vaccinated.		
	No. of Sheep.	Deaths.	Percentage of Deaths.	No. of Sheep.	Deaths.	Percentage of Deaths.
M.B. ..	513	5	0.98	487	3	0.62
F.	193	21	10.88	186	12	6.45
Whole Experiment ..	706	26	3.68	673	15	2.23

The results obtained with vaccine made from the T2 strain are thus in no way comparable with those obtained with the R2 and M.R. strains. This was not entirely unexpected, as on titration of cultures from which this vaccine was made, it was found that the toxin content was comparatively low, the minimum lethal dose of filtrate for a mouse on intramuscular inoculation being over 0.3 cc. as compared with a minimum lethal dose of 0.1 cc. or lower with batches made from R2 and M.R. strains. Subsequent laboratory experiments also indicate that the T2 strain was of low antigenic value, and it was not used further for vaccine production.

4. Field Results in 1932 Season.

The results obtained in the 1931 season, confirming those of the previous year, have shown that *B. ovitoxicus* anaculture is an efficient immunizing agent. In response to numerous inquiries from stock owners, particularly those with stud flocks, it was decided to extend the vaccination work, at the same time making a charge to cover the cost of the vaccine. As it was

impossible for the Perth laboratory to meet the increasing demand, the Commonwealth Serum Laboratory was requested to supply 100 litres of vaccine for use during 1932, and agreed to do so at a cost of 1½d. for each 10 cc. Twenty-two litres were subsequently made in Perth to supplement the Commonwealth supply.

The method of preparation of vaccine used in 1932 was somewhat modified. The cultures were incubated for 48 hours instead of 24, and they were prepared from two tried strains (M.R. and R1) of *B. ovitoxicus*. Vaccines previously used had been monovalent. For the sake of convenience, the Serum Laboratories substituted " V.F." broth for " horse-meat broth " as culture medium.

The doses of vaccine were reduced from 5 cc. and 10 cc. to 3 cc. and 7 cc. for adult sheep, and 2 cc. and 5 cc. for young sheep. It was considered that these amounts of vaccine made from the more toxic cultures would be equally effective. By reducing the dose, the cost of inoculation could also be made more reasonable.

It was found impossible to maintain the system of vaccinating only half of the flock, so that, with two exceptions, no controls were left. In most instances, large numbers of the flock were left un-inoculated, these animals being passed over because they were considered not likely to contract the disease on account of their age or condition. In some cases, only small stud mobs were inoculated. These un-inoculated sheep could not therefore be considered as controls, particularly as they were not generally run with the inoculated section of the flock.

From February to August, 1932, a total of 16,589 sheep were inoculated on 26 separate properties in the Great Southern, Midland, and Eastern districts, at a cost of 1½d. per sheep. The two inoculations were completed, in almost all instances, at least three or four weeks prior to lambing (May-July). The sheep owners were supplied with printed forms, similar to those in use for necrotic hepatitis in Victoria, for the purpose of recording full particulars of deaths occurring in their flocks each month.

There were no ill effects following inoculation with the exception of the lameness already referred to. On one property where the disease chiefly affects lambs (8-12 weeks), we inoculated 288 lambs, many of which were only 2–3 weeks old at the time of the first inoculation. Doses of 1 cc. and 2 cc. were given. No after effects at all were noted, and no deaths due to entero-toxaemia have occurred.

The results obtained for the 1932 season were again very satisfactory, although mortality occurred on 8 of the 26 properties where inoculation had been carried out (viz., S.B.R., M., W.B.—Cf. 1931 and A.R., C.O., M. & B., V. and H.).

Out of a total of 7,743 sheep inoculated on these properties, there were 30 deaths from entero-toxaemia = 0.39 per cent. In 6,795 un-inoculated sheep on these same properties, there were 93 deaths = 1.37 per cent. (In addition, there were 74 deaths among the new season's lambs.) As previously pointed out, these un-inoculated sheep were not controls, but were generally composed of sections of the flock which were regarded as being less susceptible to the disease.

The results of a controlled experiment on two properties are tabulated in the following table :—

Owner.	Controls.			Vaccinated.		
	No. of Sheep.	Deaths.	Percentage of Deaths.	No. of Sheep.	Deaths.	Percentage of Deaths.
W.B. ..	696	26	3.74	626	5	0.8
V.	413	15	3.63	287	0	0
Whole Experiment ..	1,109	41	3.61	913	5	0.55

The results of this experiment are surprisingly similar to those obtained in the previous season, inoculation again lowering the mortality rate to approximately 15 per cent. of its former value.

Monthly records of mortality on the eight properties where the disease made its appearance did not indicate any falling off in the degree of immunity over the seven months' period from the last inoculation in March until the end of the season in October.

From an experimental point of view, it is unfortunate that throughout both seasons' work the incidence of the disease has been low on all properties where vaccination has been carried out. It is notable that since 1927–28 the annual incidence of the disease has generally greatly decreased in the older settled districts. The probable reason for this has been discussed elsewhere. However, even in these areas, heavy losses are still experienced from time to time, particularly on the more highly improved properties. Prophylactic immunization is to be advocated in these special cases and for stud stock generally. The severe enzootics experienced in 1925–1927 may recur, particularly in the newer agricultural districts. Notwithstanding the decreased incidence, the demand for vaccination is still increasing.

5. The Immunization of Lambs Fattening on Peas.

In Western Australia, it is a not uncommon practice to carry June-July lambs through to fatten during the summer months on crops of shed field peas, marketing up till the beginning of April. Scouring frequently results, and a percentage of the animals die suddenly from a condition which the writer has shown to be entero-toxaemia. The owner of a property on which these investigations were carried out had for many years averaged a 5 per cent. mortality in a flock of 500–600 lambs.

In January, 1932, we inoculated 503 of his lambs, consisting of 47 Merino and 456 Shropshire and Suffolk crossbreds. The inoculation was done with anaculture 2 cc. followed by 5 cc. Ninety-five crossbred lambs were left as controls, and of these 3.15 per cent. died of entero-toxaemia. None of the inoculated succumbed. There were originally 50 of the Merino lambs, and 3 of these had died from the disease prior to the time of inoculation. The owner reported that a feature of the lambs this year was the freedom from scouring, only a few showing it. He also indicated that it was remarkable how few of the un-inoculated lambs were suitable for inclusion in the first draught for market.

This experiment indicates that lambs fattening on peas can be successfully immunized against entero-toxaemia. Inoculation can be carried out without fear of checking the lambs.

6. Laboratory Experiments with Modified Vaccines.

Although the results attending the use of formalized culture as a prophylactic vaccine had been very satisfactory, we hoped to be able to produce a better product, or rather one which would give equally good results with a smaller dosage. This investigation proceeded along two main lines :—

(i) *Alum toxoid.*—The use of tapioca, calcium chloride, and other materials injected with vaccines has been recommended as a means of increasing antigenic effect. The increased immunological response obtained is considered to result from prevention of rapid absorption and excretion of the antigen. Glenny and others (4) have used toxoid (anatoxin) precipitated with potash alum, and have obtained increased antigenic efficiency which they have shown to be due to slow absorption and elimination of the insoluble product "alum-toxoid". Following similar lines, attempts were made to immunize guinea pigs and to hyper-immunize rabbits with *B. ovitoxicus* alum toxoid.

The results of a series of experiments indicated that, in laboratory animals, the response to these products was not superior to that obtained with anaculture. It was concluded that the dead bacteria in the vaccine promoted sufficient local reaction (Cf. sheep) to prevent the too rapid absorption and elimination of the anatoxin, as well as, the bacteria, themselves possibly acting as antigens.

(ii) *Lamb dysentery bacillus anaculture.*—In order to make it clear why the lamb dysentery bacillus should be tried as an immunizing agent against *B. ovitoxicus*, it is necessary to give a brief account of the "*B. welchii* group."

The writer (loc. cit.) has discussed the antigenic relationships of the members of this group, viz., *B. welchii*, the lamb dysentery bacillus, *B. paludis*, and *B. ovitoxicus*. On account of the morphological and cultural resemblances of the last organism to *B. welchii*, we hesitated before giving it specific identity instead of describing it merely as a type of *B. welchii*. It was pointed out that the group required further investigation. Previous classifications of *B. welchii* have been based on purely biochemical grounds and antigen relationships have not been considered. Wilsdon (5), however, has recently published a more satisfactory classification based on toxin antitoxin relationships. The classical *B. welchii*, the lamb dysentery bacillus *B. paludis*, and another type of *B. welchii* of animal origin are classified as *B. welchii* types A, B, C, and D respectively. He suggests that the toxin of type A contains only one antigenic unit which is common to all four types, whereas type B, the lamb dysentery bacillus, contains three, one of which is common only to it and type C. Type D contains two, one common only to it and to type B, the second being the unit common to all the types.

Although there are slight cultural differences between the lamb dysentery bacillus and *B. paludis*, their toxins and antisera give complete cross immunization, and the organisms can only be satisfactorily differentiated by means of the relationship of their toxins and antisera to those of Wilsdon's *B. welchii* type D, or to *B. ovitoxicus*. The two latter organisms may prove to be identical, although the properties of the toxin of type D as described by Wilsdon differ in certain respects from those possessed by *B. ovitoxicus*. Dalling (2) apparently considers that *B. ovitoxicus* is identical with *B. paludis*.

This finding is difficult to understand in view of our results (Bennetts loc. cit.) which were checked by Dr. A. W. Turner, in Melbourne, and have since been confirmed by Gill (3) for both Western Australian and New Zealand strains of *B. ovitoxicus*.

In a personal communication early in 1932, Dr. L. B. Bull, Director of the Pathological and Bacteriological Laboratory, Adelaide Hospital, suggested an antigenic relationship of the members of the *B. welchii* group which was somewhat similar to that later reported by Wilsdon. From a consideration of our findings with regard to the toxin antitoxin reactions in the group, he thought that the lamb dysentery bacillus toxin might contain the most evenly balanced mixture of antigenic components, and that consequently it might be advantageous to use this organism for prophylactic immunization against *B. ovitoxicus*. A further argument in favour is that this organism produces a much more potent toxin than does *B. ovitoxicus*.

An attempt was made to immunize guinea pigs against *B. ovitoxicus* toxin by means of lamb dysentery anaculture. Filtrates of the culture from which this was prepared had a mouse minimum lethal dose of 0.01 cc. Each of a series of guinea pigs was inoculated with an initial dose of 1 cc. of this vaccine, followed three weeks later by a second inoculation of 2 cc. A parallel series of guinea pigs were inoculated with the same amounts of *B. ovitoxicus* anaculture (mouse M.L.D. 0.1 cc.). The inoculations were subcutaneous. Three weeks after the second inoculation, the immunity was tested by intramuscular inoculation with solutions of standardized desiccated *B. ovitoxicus* toxin. The guinea pigs which had been inoculated with *B. ovitoxicus* anaculture survived the effect of 1 M.L.D. of toxin, but those receiving 5 M.L.D. died some hours later. On the other hand, lamb dysentery anaculture (made from a more toxic culture) gave no protection against even 1 M.L.D. of *B. ovitoxicus* toxin, animals receiving this dying as rapidly as the controls. Admitting that, as found by other observers, the immunity response is not good in guinea pigs, the result of this experiment was distinctly discouraging, and on account of the pressure of other work, the investigation was not carried any further.

If, as seems very likely, the arrangement of antigenic constituents in the toxin of *B. ovitoxicus* is similar to that of Wilsdon's *B. welchii* type D, the reason for the failure of lamb dysentery antigen to immunize against this toxin would be quite clear.

7. Further Field Work.

The prophylactic inoculation of sheep with *B. ovitoxicus* anaculture is being carried out under the supervision of the Western Australian Department of Agriculture. Already, applications have been received for the inoculations of some 25,000 sheep this season, and this work is proceeding.

An experiment is projected, the purpose of which is to determine experimentally the duration of immunity following on routine vaccination procedure.

8. References to Literature.

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Some Preliminary Tests on the Control of *Thrips imaginis* Bagnall.

*By J. W. Evans, M.A.**

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Summary.

During the spring of 1932, preliminary tests were made with certain materials as repellents or deterrents for thrips. The work was considerably hampered by the cold weather during October, which necessitated a curtailment of the planned programme of experiments. The sprays tested were lime-water and lime-sulphur and resin; the dusts were nicotine, sulphur, and pyrethrum. Pyrethrum powder, even when mixed with sulphur in the proportions of 1 part of pyrethrum to 10 parts of sulphur, was shown to retain its strength as a repellent for two days. The other substances tested were of no value.

1. Introduction.

A series of tests with certain materials was carried out during the spring of 1932 for the purpose of determining the repellent value of the materials. In all, 100 separate experiments were made, from the end of August until the middle of November. The unfavorable weather conditions prevailing during October, when apple trees were blossoming, rendered it difficult to obtain any results during that month. However, such results as were obtained, combined with those from tests carried out in September and November, when the weather was more settled and the thrips more abundant, are sufficient to show the value of certain preparations, and the results that may be expected with others. The following materials were tested:—*Sprays*—lime-water, and lime-sulphur and resin. *Dusts*—sulphur and pyrethrum (separately and combined), a proprietary nicotine dust, and a proprietary nicotine-tar dust. These were chosen as having possible value either as repellents or deterrents, or as possessing killing properties in addition to repellent ones. No tests were made with insecticides as such, the work of Zeck and Noble† having demonstrated the value of kerosene emulsion, a cheap and easily prepared spray, in this connexion.

Although *Thrips imaginis* is the insect responsible for certain damage to deciduous fruit blossoms, three other species of thrips occurred in small numbers in nearly every sample of blossom taken during the spring. These were *Isoneurothrips australis* Bagnall, *Thrips tabaci* Lind., and *Haplothrips victoriensis* Bagnall. For record purposes, the insects taken in every count were separated into species, sexes, adults, and nymphs; but for the purpose of the tests, the total number of thrips in the blossom examined was used as an index to the efficiency of the treatment.

2. Treatment.

(i) *Lime-water.*—Experiments were made with lime-water as a spray, owing to its supposed efficacy as a thrips deterrent, reports having been received of the success attending its use during the 1931 thrips

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† Zeck, E. H., and Noble, N. S.: *Agric. Gaz. N.S.W.* **43**: 231, 1932.

outbreak. It was made up in the proportions of ½ lb. of fresh lime to 1 gallon of water. In four tests, the average number of thrips per blossom (plum and apple) 24 hours after treatment was 2.2, compared with an average number of 3.3 thrips in the untreated controls. The numbers of blossoms examined in these experiments were 190 treated, and 240 controls. In two instances the blossoms were scorched. This spray has no deterrent value.

(ii) *Lime-sulphur and Resin.*—This spray was tested in the proportions given in a previous publication (Coun. Sci. Ind. Res. (Aust.) Pamphlet 30, 1932), where it was stated that it had given promising results in laboratory and small field tests. It had been noted during the spring of 1931 that while lime-sulphur was of no value against thrips, owing to its poor wetting and sticking properties, when added to a solution of resin dissolved in methylated spirits and ammonia it became an efficient contact insecticide, and had some repellent value. The tests carried out in 1932 demonstrated that its repellent qualities are too short-lived to be of any real value.

(iii) *Nicotine Dusts.*—Two proprietary nicotine dusts were used in order to compare their efficiency with pyrethrum. It was found that they killed thrips quicker than pyrethrum, but that their effect was not lasting. A nicotine-tar dust gave promising results early in the season when the temperatures were low, but during hot weather this advantage over the ordinary nicotine dust was not apparent. Twenty-four hours after the application of nicotine dust to five roses, 218 thrips were found in them, while there were 422 thrips in the five roses examined for control purposes. A similar result was obtained with apple blossom, in which an average of six thrips a flower was found in dusted blossoms 48 hours after treatment, while an average of three thrips a flower was found in the control blossom. With nicotine-tar dust, 48 hours after its application to plum blossom, the average number of thrips in one blossom was 0.9, while the average number in the controls was 1.2; 240 treated flowers and 220 control flowers were examined in the experiment.

(iv) *Sulphur.*—Sulphur dust was tried out early in the season. It has little repellent value. With *Prunus pissardi* one hour after treatment, the average number of thrips per blossom was 1 (196 blossoms), controls 1 (142 blossoms). After 24 hours, the numbers were 1 (292 blossoms), controls 2 (157 blossoms).

(v) *Pyrethrum.*—Two brands of pyrethrum were tested, a proprietary preparation, and an ordinary commercial pyrethrum powder. The latter differed from the former in not having a carrier incorporated with it. This dust was tested on account of its known insecticidal value and reported repellent qualities. On account of its prohibitive cost, a series of tests were made with pyrethrum and sulphur mixed together in different proportions. Sulphur was chosen as a carrier as it is a heavy dust, and settles quickly; it is also inexpensive. Experimental applications of the dust were made with pyrethrum alone and with pyrethrum mixed with sulphur in the proportions of 1 part of pyrethrum to 4, 5, 8, and 10 parts of sulphur (by weight). It was found with all tests that, even when diluted in the proportions of 1 part of pyrethrum to 10 parts of sulphur, almost complete control of thrips was obtained over a period of 48 hours from the time of application. In five experiments with dust at the latter strength, a total

of 88 thrips was obtained from 670 blossoms of treated plum trees, 48 hours after application. From 378 undusted plum blossoms, 945 thrips were obtained.

During October, the weather was consistently cold, and no opportunity offered of determining the lasting qualities of pyrethrum on apple blossom during hot weather. In order to obtain some idea of this important point, during November, 40 Cecil Brunner roses growing on one hedge were dusted thoroughly with 1 part of pyrethrum mixed with 8 parts of sulphur. The roses were not fully open, and so the dust was unable to penetrate into the blossom. The numbers of insects in both treated and check flowers increased during the first three days as the developing roses became more attractive, and the temperature increased. The numbers dropped on the fourth day with the temperature, and as the roses had passed their prime. Ten dusted roses and ten untreated ones, at a corresponding stage of development from a neighbouring hedge were picked, and their thrips population recorded every day for four days. The maximum shade temperatures for the four days were 24.3° C., 28.3° C., 32.1° C., and 22.2° C. The numbers of thrips in the dusted flowers examined on the four days were, 50, 121, 332, and 601, and the numbers in the check flowers, 249, 440, 1,704, and 540 thrips respectively. This test demonstrated that pyrethrum retains its properties for three days at a high temperature, but not for four.

Included in the programme of tests planned for October were dusting experiments on blocks of apple trees in different stages of blossom development, from early pink-bud stage to full bloom. However, it was possible to undertake only a few of the intended series, and with only one series were any significant results obtained. The other series were either spoilt by wet weather or rendered valueless by the small numbers of thrips in the check blossom, often as low as an average of 1 thrips to 2 flowers.

Five Cleopatra apple trees in full bloom were dusted each with ½ lb. of dust (1 part pyrethrum and 5 parts sulphur). After 24 hours, a total of 3 thrips were obtained from 204 blossoms picked at random. From 196 blossoms picked from check trees, 415 thrips were obtained.

3. Discussion and Conclusions.

Results of previously published experiments (Coun. Sci. Ind. Res. (Aust.) Pamphlet 30, 1932) demonstrated that sprays containing strong smelling essential oils, known to be repellent to thrips, are of no practical value in the field, their effect being too short-lived. Contact insecticides are of little value for the same reason. The substances dealt with in this paper have one feature in common—they leave a deposit on the leaves and petals to which they are applied. In the case of lime-water, the deposit is inert, but it was considered that a coating of lime might deter the thrips from feeding on sprayed blossom.

Dusts have frequently been advocated for use in the control of thrips, since, in a given time, it is possible to cover a larger acreage with a dust than with a liquid spray. A dust can be thrown over a tree as a cloud, whilst, to be of any value, spraying entails careful work, the nozzle being applied in turn to each cluster of blossoms.

However, if a dust is to serve the double purpose of acting as a contact insecticide and as a subsequent repellent, it is essential that a good cover be given. Consequently, unless the material used is cheap

and can be put on generously, it must be applied as in spraying, each of the individual clusters, as far as possible, receiving an application. The sepals, calyx cups, and flower stalks of apple blossom are hairy; this facilitates the retention of the dust, which is an important factor. In the experiments described in this paper, sulphur was used with pyrethrum on account of its cheapness and weight. Being a heavy dust, it settles quickly; a lighter material, unless applied in very still weather, is largely carried away by the wind, only a little settling on the tree. Sulphur has poor sticking qualities. During the course of some experiments carried out at the Gipsy Moth Laboratory, in America,* some promising adhesives were found; these, in the approximate order of importance, are, commercial ferric oxide, powdered casein glue, linseed oil or fish oil, and finely powdered milk. The best results were obtained when the powdered adhesive made up 20 per cent. of the weight of the dust mixture. Other recent work in America,† having as its purpose the development of dusts with better sticking qualities than those ordinarily used, has shown that increased adhesiveness can be obtained by adding small quantities of mineral oil to the dust.

In a previous publication on the control of thrips, to which reference has already been made in this paper, it was pointed out that, even during a season when thrips are present in "plague" numbers, it is only on days with very high temperatures that the insects are in sufficient numbers to constitute a danger to apple blossom. It was also shown that these periods are of short duration, seldom lasting even as long as four days. Pyrethrum, when mixed with sulphur in the proportion of 1 part of pyrethrum to 10 parts of sulphur, has been shown to give effective protection for two days when it is applied thoroughly to blossom, and not as a cloud. This is probably the longest period over which protection can be expected during such weather; buds that have been dusted on the outside will open and expose untreated petal surfaces, and it is doubtful whether pyrethrum is repellent except at very close quarters.

The wholesale price of imported pyrethrum in Australia is 2s. 6d. a lb., and the use of this dust, unless produced locally and the price very considerably lowered, will not be economically possible unless diluted with a carrier.

It must be stressed that the experiments carried out to date have been designed more for the purpose of determining the nature of materials suitable for thrips control, rather than a search for any specific substance. The results given in this paper are only a further step in the development of the investigation. Many substances and methods of application have yet to be tested.

Acknowledgments.

The work was carried out under the direction of Dr. J. Davidson, at the Waite Agricultural Research Institute, Adelaide.

I am indebted to Mr. N. Wicks, of Balhannah, for putting blocks of trees in his orchard at my disposal for field tests, and to Mr. G. Quinn, Chief Horticultural Instructor in South Australia, and Mr. R. Fowler, Manager of the Government Experimental Orchard, for the facilities made available at the Blackwood Orchard.

* Potts, S. F., and Barnes, D. F.: "Adhesives and carrier for insecticide dusts." *J. Econ. Ent.* **24**: 1,110, 1931.

† Flint, W. P.: "The use of mineral oils for better dusts." *J. Econ. Ent.* **25**: 269, 1932.

The Hydrogenation of Coal and Oil.

By L. J. Rogers, M.Sc., B.E.

1. Introduction.

In 1930, Dr. A. C. D. Rivett, Chief Executive Officer of the Council for Scientific and Industrial Research, made some inquiries into the position of industries for producing oil from coal in England and Germany. His observations are embodied in a report* submitted to the Vice-President of the Executive Council. At that time little information had been published about the catalytic hydrogenation of coal and tar, which is probably the most promising process for converting coal into oil in Australia. A considerable amount of publicity has been given to this process lately in England, and to a lesser extent in Australia also. The following description of the process, its achievements, limitations, and present stage of development may therefore be of some interest.

If various solid and liquid fuels be compared on the basis of their ultimate analysis, it becomes evident that, with one or two unimportant exceptions, the order of increasing value is also the order of increasing hydrogen-carbon ratio. In the following table of representative analyses, the "disposable" hydrogen is the percentage present in excess of the quantity required to combine with the oxygen in the fuel.

Ultimate Analyses of Typical Fuels.

(*On a dry and ash-free basis.*)

		Wood.	Peat.	Lignite.	Bituminous Coal.		Petroleum.	
					Non-coking.	Coking.	Fuel Oil.	Petrol.
Carbon	%	50	57·5	70	81	86	86·1	85·3
Hydrogen	%	6	5·5	5	5·3	5·4	11·8	14·7
					Including an allowance for sulphur			
Oxygen	%	43	35·0	23	12	6·5	1	..
"Disposable" Hydrogen	%	0·6	1·1	2·1	3·8	4·6	11·7	14·7

The processes by which coal and petroleum have been formed in nature have involved the loss of water and gases rich in carbon. Hydrogen has, therefore, become more and more concentrated in the residue. Different grades of solid fuels represent the different stages at which the natural process of development has been arrested. The more mature coals are, therefore, richer in available hydrogen than the younger fuels. By inducing these fuels to combine with more hydrogen, it is possible to imitate the maturing process in the laboratory, and so obtain products of higher unit value. In this way a material resembling coal has been prepared from wood; non-coking coal has been transformed into coking coal; a liquid resembling crude petroleum has been produced from lignite and coal; and heavy oils and tars have been converted into petrol. This is the process which is now being developed under the name of hydrogenation.

* "Memorandum on the Present Position of Investigations on the Production of Oil from Coal," by A. C. D. Rivett, M.A., D.Sc., Parliamentary Paper No. 178. F.1064. Govt. Printer, Canberra (1931).

2. Historical.

Coal was first hydrogenated in 1868 by Berthelot, who obtained a mixture of organic liquids by heating coal under pressure with hydriodic acid. Bergius's first experiments were undertaken in an investigation into the origin of coal. By heating cellulose in an autoclave with water, he produced a material resembling coal, and concluded from his experiments that liquid hydrocarbons could be formed by carrying the process a stage further. Bergius's original patents were taken out in 1913 and 1914, but further progress was delayed by the war. By 1921, a semi-commercial plant had been put into operation at Rheinau, and in 1928 a plant with a capacity of 100 tons per day was constructed at Duisberg. The process soon proved to be uneconomic, however, and the plant was closed down.

The original Bergius process converted coal into a mixture of motor spirit, a phenolic middle oil, and pitch, roughly in equal proportions. In the last ten years, investigations with which Bergius has had no connexion have proved the possibility of preparing petrol as the only liquid product. These developments have been effected by the German chemical combine (the Interessen Gemeinschaft) and by Imperial Chemical Industries. Credit for the original idea must be given to the German company, which has confined its attention largely to the treatment of brown coal tar. In England, Imperial Chemical Industries has attacked the more difficult problem of hydrogenating solid coal, with very satisfying results from a technical, if not from an economic, point of view.

The results achieved in Germany were so encouraging that, in 1928, the Standard Oil Company purchased a half interest in the I.G. process. In the last two or three years, a combine of world-wide interests has been formed for the pooling of patent rights, and the control of the hydrogenation process. The partners in this combine are the Interessen Gemeinschaft, Imperial Chemical Industries, the Royal Dutch-Shell group, the Standard Oil Company, and, through the latter, most of the oil companies of America.

The present position of the industry is roughly as follows :—In Germany there are three plants in operation, a large one at Leuna, near Leipzig, and two smaller ones at Merseburg and Oppau. About 400 tons of petrol are produced per day from brown coal tar and heavy petroleum residues. The Company claims to have hydrogenated brown and black coal successfully, but the prices of raw materials at present are such that the treatment of brown coal tar is a more economic proposition.

At Billingham-on-Tees, in England, there is a 15-ton per day pilot plant, upon which sufficient work has been done to enable a full-scale commercial plant to be designed. The operation of the 15-ton unit itself is not economic, so it has been closed down for the last year.

In the United States of America, two oil hydrogenation plants have been constructed with a capacity of 5,000 barrels (700 tons) per day each. The price of petrol in America is such that the hydrogenation of heavy oil to motor spirit is hardly possible commercially. Having satisfied itself, therefore, that petrol production presents no unsolved technical difficulties, the Standard Oil Company has set itself the task of investigating various special developments of the process. Asphaltic residues, which cannot be cracked in a plant of the orthodox type, have been found amenable to treatment with hydrogen. A motor spirit has been produced with a high flash point, and this product is being recommended for use in air craft, to reduce the fire risk. High-grade lubricants have been prepared from inferior stock. Hydrogenated lubricating oils indeed are much superior to the products prepared by

distillation alone, having a low setting point and a comparatively high viscosity at elevated temperatures. The Standard Oil Company is marketing an hydrogenated product under the name of " Essolube " for blending with ordinary lubricating oils. Such developments represent the most likely immediate field of application in the petroleum industry.

3. The Hydrogenation Process.

The original Bergius process seems so unlikely at present to make any commercial progress that no useful purpose would be served by describing its operation. The main difference between it and the modified processes employed by the Standard—I.G. Company consists in the use of catalysts, which, by speeding up the reaction, make possible a reasonable throughput for a plant of economic size. Effective hydrogenating catalysts, such as nickel, have been known for many years and have been widely employed in associated processes, such as the saturation of fish oils. But the catalysts used until ten years ago were susceptible to poisoning by sulphur, and, therefore, could not be applied to the hydrogenation of coal, tar, and crude oil. An intensive search in the last ten years has resulted in the discovery of many other catalysts, such as molybdenum oxide, molybdenum sulphide, tungsten oxide, tungsten sulphide, and cobalt sulphide. These are just as effective as nickel, but they are immune to sulphur poisoning. It is this achievement, alone, which has enabled hydrogenation to reach its present stage of development, and which may in the future make commercial application possible.

The catalytic process for hydrogenating coal may be carried out in two or three stages. Two are used in England and three in Germany. In the first, pulverized coal is mixed with sufficient heavy oil to make a paste which may be pumped. After being heated to a temperature of about 450° C., it is forced into a vertical reaction vessel, constructed of a special alloy steel, and in which a pressure of 250 atmospheres is maintained. Hydrogen also is heated and pumped into the chamber with the coal paste. The operation is continuous, and the product from this stage consists of a mixture of light, medium, and heavy oils, and a small amount of solid matter. The crude product is fractionated at temperatures of 170° C. and 300° C. approximately. The spirit is sent to the refinery, the middle oil passes to the final stage of the process, and the heavy oil is centrifuged or distilled, to separate the original ash of the coal and what little unconverted material is present. In the two-stage process, the throughput of the first unit is adjusted to provide just sufficient heavy oil for pasting the raw coal. In the three-stage process, the throughput is increased, and the reaction is arrested at a stage where the product is mainly a heavy oil. After removal of solid matter from this oil, it is given a second treatment before proceeding, as a middle oil, to the final stage of conversion.

The middle oil is hydrogenated in the vapour phase at a temperature of about 500° C., but in the presence of hydrogen at the same pressure as before. After passing through the converter, the vapours are condensed and fractionated. The oils boiling outside the petrol range are returned to the plant, and re-cycled until conversion is complete. In this way, the original coal is ultimately transformed mainly into motor spirit, the yield being between 60 per cent. and 65 per cent. by weight of the dry ash-free coal, or approximately 190 gallons per ton. The other products are water, ammonia, gas, and a small quantity of incompletely hydrogenated material.

The temperature in each stage, and the catalyst employed, are chosen so as to give the best conversion in that stage to the desired products. In the liquid phase stages—the first of the English process, and the second as well in the German system—the catalyst is mixed with the charge. For the vapour-phase reaction, the catalyst is suspended inside the converter. Tar or heavy oil is hydrogenated in two stages, corresponding to the second and third (the "sumpf" and the "gas") stages of the German process.

The motor spirit produced requires practically no refining, and is an excellent anti-knock fuel. The middle oils formed in the incomplete hydrogenation of coal are highly aromatic and phenolic, and therefore of doubtful value as a fuel for Diesel engines. The heavy oils from coal appear to have no constitutents with lubricating properties of any value. The process is, therefore, essentially one for producing petrol.

In the conversion of bituminous coal into petrol, the consumption of hydrogen is 9 or 10 per cent. by weight, or roughly 35,000 to 40,000 cubic feet per ton. For treating tar, only half this quantity is required, and for petroleum residues still less. In addition to the hydrogen actually absorbed, a considerable excess must be passed through the plant to prevent coking. In the vapour phase stage, the hydrocarbon gases generated in the process must not be allowed to dilute the hydrogen to a concentration less than about 85 per cent. In the liquid-phase stage, a minimum concentration of 70 per cent. is satisfactory. Enormous volumes of hydrogen must therefore be manufactured for the process and compressed to a fairly high working pressure.

Hydrogen is manufactured on a very large scale in the synthetic ammonia industry. The favourite method of production is the catalysed reaction between steam and water gas at about 500° C. The carbon dioxide formed in the process and the residual carbon monoxide are subsequently removed by solution under pressure. Coke oven gas is also extensively employed for producing hydrogen by the Linde process, in which the other constituents are separated by liquefaction at low temperatures. In a few instances cheap electric power is used for generating hydrogen by electrolysis.

The excess hydrogen required for the coal treatment process may be recovered from the residual gases. The hydrocarbon gases formed may also be used as a source of part or all of the fresh hydrogen required. Steam is mixed with the gas and heated at a low pressure to a temperature of about 1000° C. The resulting mixture of gases is then converted into hydrogen by the processes applied to water gas or coke oven gas. Other gases may be substituted for process gas, water gas, or coke oven gas, if available cheaply. In one of the American plants, for instance, natural gas is used. Whatever may be the source of hydrogen, however, the cost of manufacture and compression is bound to be high. The lowest cost of hydrogen on a large scale and under European conditions is likely to be about 9d. per 1,000 cubic feet. The cost of manufacturing hydrogen, therefore, is roughly equivalent to 2d. per gallon of petrol produced.

High as this charge may appear, even this figure can be realized only by operating on a very large scale. The amount of power required for compressing and circulating hydrogen, and for other purposes, also indicates that a big production is essential for economy. In England, it is considered that the economic unit should have a treatment capacity of at least 500 tons, and preferably 1,000 tons of coal per day. In Germany, the development of the hydrogenation process is held to be linked with the ammonia industry so that each may benefit by the reduced price of hydrogen.

4. Economics.

It has been estimated by Imperial Chemical Industries that a plant for hydrogenating 1,000 tons of bituminous coal per day would cost about £8,000,000 sterling. The cost of operating the plant, when paying 12s. 6d. per ton for best small coal, would amount to 7d. per gallon. In order to attract investment in an enterprise of so speculative a nature, it would probably be wise to provide for liberal dividends, raising the total cost of production to 10d. Imported spirit is being landed in England for 1s. per gallon approximately, including 8d. duty. It would appear, therefore, that the commercial application of the hydrogenation process is dependent upon the continued imposition of this duty and exemption from any excise charges.

The Government has been urged at times to interest itself in the establishment of the industry as a means of relieving unemployment. The production of a 1,000-ton per day plant, however, would involve the Exchequer in a loss of £2,000,000 revenue per annum. The employment created directly or indirectly would only absorb 5,000 men approximately, so that the Government would be required to subsidize the industry to the extent of some £400 per annum for every man employed. When it is considered, furthermore, that the British Government and the investing public have large interests in oil companies, it is not difficult to understand some reluctance to invest money in hydrogenation.

It has been stated in England that motor spirit can be produced from tar costing 25s. per ton at the same price as from coal at 12s. 6d. per ton. Opinion appears to be growing that the hydrogenation of tar is a more attractive proposition than the treatment of coal. The total amount of tar produced in England, however, is only about 40,000,000 gallons per annum. Much of this would be unsuitable for the process, and the surplus available at 25s. per ton would not be sufficient for the operation of an economic unit.

Hydrogenated spirit has been sold on a large scale in Germany (400 tons per day) at 1s. 8d. per gallon retail price. Although the scale of operation may not be large enough for economic working as an independent industry, the works at Leuna and elsewhere enjoy the advantages of cheap hydrogen, tar, and power, owing to the fact that they are attached to synthetic ammonia plants. These are the conditions stated in Germany to be most favorable for hydrogenation. The Government has given concessions in railway freight to the domestic product, and a further advantage arises in the location of the plant remote from ports where foreign petrol is landed, but close to large markets and cheap supplies. Nevertheless, there is no record of the distributing company having made a profit, and it is reported that the Leuna factory was closed down for part of last year. At Oppau and Merseburg, a short week was introduced in order to reduce costs. Apparently, commercial operation is still uncertain even under German conditions.

No information has been published regarding operating expenses in the American plants. It has been stated, however, that the first works cost $8,000,000 to erect, that the second cost $5,000,000, and that subsequent plants of this size (700 tons per day) could be constructed for $2,000,000. The lowness of these figures compared with the English estimate is rather surprising, even when due allowance is made for the extra plant required to treat coal.

5. The Prospects of Hydrogenation in Australia.

In spite of the low cost of brown coal in Victoria, it is probable that hydrogenated petrol would be more cheaply produced from New South Wales bituminous coal. There is no synthetic ammonia industry in Australia, which might enable hydrogenation to be practised on a comparatively small scale. Nor is there any appreciable quantity of tar available for conversion into motor spirit. The industry, therefore, will probably need to be established, if at all, with black coal as the raw material, and on a fairly large scale.

A plant with a capacity of 1,000 tons of coal per day would probably cost about £12,000,000 in Australia. Based upon comparative English estimates, the production costs, including interest charges, would probably amount to 1s. 3d. per gallon of petrol. Imported spirit can be landed at Australian ports, with duty and other charges paid, at the same price or even a little lower. The industry would enjoy no advantage in distribution expenses, for most of the product would need to be transported by sea to the main markets. In Australia, as in England, therefore, the successful application of the process, in the state to which it has been developed to-day, would seem to depend upon some form of Government subsidy.

Admittedly, many arguments may be advanced for the establishment of the industry even in the face of a certain loss. As a measure for relieving unemployment, however, it does not appear very attractive. It is to be hoped, however, that by accumulated experience and research in the operation of high pressure processes, such economies will be made that commercial application will become possible in Australia.

Ragwort Poisoning in Cattle in Victoria.

*By D. Murnane, B.V.Sc.**

1. Introduction.

Earlier experiments by Gilruth (Report of Division of Veterinary Science, N.Z. Dept. of Agric., 1901-2 and 1902-3), demonstrated the fact that ragwort (*Senecio jacobaea*) is toxic to horses, cattle, and sheep in New Zealand, and later (N.Z. Dept. of Agric. Report 1904) that sheep if fed on pasture lands almost exclusively occupied by ragwort would also become subject to similar pathological changes in the liver. Further, the Pictou cattle disease of Nova Scotia has been demonstrated by Adami and others to be due to ingestion of ragwort producing chronic liver changes. Although this plant is plentiful in certain parts of Victoria, we have not seen any authentic reports which conclusively establish the fact that the plant is toxic in this State.

The purpose of this note is to record findings which incriminate ragwort in the South Gippsland district.

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In association with the Veterinary Branch of the Department of Agriculture of Victoria, a visit was made to a dairy farm at Toora where losses had occurred. It was ascertained from the owner that cows usually remained in good condition for about twelve months after arrival on the property, after which time, sooner or later they developed characteristic symptoms and died within three to twelve weeks. Most of the losses occurred during the spring months, but some deaths took place during the autumn.

Cattle were frequently seen eating ragwort, which is very plentiful in the locality, and which seems more palatable when dry after having been cut. Certain animals acquired a particular liking for the plant. Young cattle appear to become affected more quickly than do older animals. The owner has had no losses in animals other than cattle.

(i) *Symptoms.*—After grazing for twelve months or more on the property, cattle develop typical symptoms, exhibiting dullness, loss of appetite, a jaundiced condition of the eyes, together with a peculiar staring appearance. There is loss of weight, and, in the case of lactating animals, a very marked diminution in the milk supply. The milk itself has a peculiar odour and a pronounced acrid flavour, rendering it quite unfit for use. The affected animal frequently develops a scabby condition of the skin, particularly that of the udder and teats. In the later stages, there is impaired vision, staggering gait, persistent diarrhoea, a marked thirst, and progressive loss of condition. The milk supply ceases, food is not taken, the animal becomes weaker, goes down, and eventually dies—frequently in a swamp or waterhole into which it has wandered to quench its insatiable thirst.

(ii) *Post-Mortem Examination.*—An affected animal showing typical symptoms was killed and examined immediately.

The subcutaneous tissue and fat were very yellow. There was a considerable excess of straw-coloured peritoneal and pleural fluid. The rumen and omasum were partly filled with ingesta; the reticulum and abomasum were empty. The large and small intestines contained a small quantity of fluid ingesta. The submucosa of the abomasum was extensively infiltrated with clear semi-gelatinous fluid—to such an extent that the mucous membrane was thrown into folds, and the wall of the organ was increased in thickness to two inches. A similar condition existed throughout the whole length of the small intestine. In addition, the omentum and mesentery were highly charged with this clear, semi-gelatinous fluid, as were the whole of the mesenteric lymph glands, which were also rather haemorrhagic on incision. Much free fluid could be expressed from the incised glands. The bladder was empty, and the kidneys showed no abnormality. The liver was slightly blue in colour, firm, and rather elastic to the touch. The capsule was somewhat adherent, and did not strip as readily as normally. The gall bladder was distended. The lungs were normal; the heart showed sub-endocardial haemorrhages in the left ventricle.

Specimens were preserved and taken back to the laboratory for microscopical examination.

(iii) *Differential Diagnosis.*—As some of the symptoms—namely emaciation, persistent diarrhoea, decreased milk yield, normal temperature, impaired appetite, abnormal thirst, and exhaustion—are all

common also to subjects with Johne's disease, scrapings of the mucous membrane of the intestine were taken. Subsequent microscopical examinations, however, failed to reveal the presence of any acid fast organisms indicative of Johne's disease.

(iv) *Microscopical.*—In the liver there was congestion beneath the capsule, which was definitely thickened, with fibrous processes invading liver tissue, both inter- and intra-lobular, and in the region of the portal canals. Other organs were normal

(v) *Diagnosis.*—From the history, symptoms, post-mortem, and microscopical findings, it was concluded that the condition was that of chronic ragwort poisoning.

2. Feeding Experiment.

In order to confirm this finding, it was decided to obtain supplies of ragwort from this Gippsland property, and to feed it to a bovine at the Veterinary Research Institute.

A young bull received 336 lb. of the semi-dried flowering plant in daily doses extending over a period of six weeks. During the fourth week, the animal became visibly affected, and developed a marked thirst and persistent diarrhoea. By the fifth week, he was showing loss of condition, loss of appetite, profuse diarrhoea, and increasing thirst.

At the sixth week, the animal became prostrate and unable to rise, was dull, very much "tucked up," and refused all food. At the end of the sixth week, death took place.

(i) *Post-Mortem Examination.*—Such an examination was made immediately.

The only abnormalities were highly congested mucous membranes of abomasum, large and small intestines, with considerable gelatinous infiltration of the submucosa of abomasum and intestines. The liver was mottled and slightly tough to the touch.

(ii) *Microscopical Appearance of Liver.*—Although there appeared to be some increase in the amount of fibrous tissue present, there were no gross changes in the organ.

3. Conclusions.

Ragwort in the Gippsland district of Victoria is toxic to cattle, and apparently is responsible for losses in dairy herds in that locality.

The post-mortem findings very closely resemble those of ragwort poisoning described by Gilruth in New Zealand.

Eradication of the plant is recommended. Where this is not possible, the infested areas may be stocked with sheep, which, according to Gilruth's experience in New Zealand, can be utilized to eradicate the weed. Sheep suffer little effect from the toxic principle of ragwort save in cases where the pasture is almost entirely supplanted by the weed, and when the animals are so fed for prolonged periods. In any case, sheep can be sold and replaced each year, which would not be practicable with dairy cows.

Caseous Lymphadenitis Investigations.

I. Infection Experiments.

*By D. Murnane, B.V.Sc.**

Extensive observations, involving the manual examination of many thousands of sheep in different parts of Victoria during the past few years, have indicated that the percentage of infection is very much higher in machine-shorn than in blade-shorn sheep.

The suggestion has been put forward by various workers that in the case of machine-shorn sheep the greater degree of wounding—presumably with contaminated combs and cutters—has been responsible for the higher rate of infection. Others have expressed the opinion that, although the machine-shorn (and hence more severely wounded) sheep seem to contract infection more readily than blade-shorn animals, the actual inoculation of the wounds may not be commonly by means of contaminated shearing hand-pieces. Earlier experiments conducted by us on an infected property in Victoria (see this *Journal*, **4**: 135, 1931) lend some support to this latter view.

Subsequently, Seddon and Belschner (*Agric. Gaz. of N.S.W.*, **43**: 525, 1932) recorded details of an experiment which, they consider, gives every indication that the infection takes place in the counting-out pens and yards after shearing.

With the idea of investigating this point further, it was decided, at the suggestion of Dr. Gilruth, to carry out a further experiment at the above-mentioned infected Victorian property. Guinea pigs were used in the tests, as these animals are undoubtedly much more susceptible to caseous lymphadenitis infection than are sheep.

(i) Experiments in Counting-out Pens and Yards.

Group 1: 52 guinea pigs were transported to the property on the 20th October, 1932, immediately shearing operations had ceased. Each animal was closely clipped over the "withers," and two triangular flat-type wounds, with sides about ½ inch in length, were made with sharp scissors in the clipped area. After bleeding had ceased, the animals were placed in a recently used small "counting-out" pen, beneath a large 6 feet x 4 feet fly-proof cover, and were allowed to run about. They remained in the pen for eight hours, during which time the dust was kept stirred up by "flopping" the surface of the pen with a sack.

The animals were then removed, replaced in separate tins with fly-proof covers, and brought back to the laboratory. The surface dust from the adjoining counting-out pen was swept up and also brought back to the laboratory. This material was used for treating further groups of animals.

Group 2: 25 guinea pigs were similarly clipped and wounded, and rather freely dusted with the counting-out pen sweepings. Each animal was then placed in a separate tin with fly-proof lid.

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Group 3: 25 guinea pigs received similar treatment to those in Group 2.

Group 4: 25 guinea pigs received treatment similar to those in Group 2, except that the dusting was very light.

Nine days after exposure to infection, 2 animals of Group 1 died; within seven days of exposure to infection, 13 animals of Group 2 died; within six days of exposure to infection, 8 animals of Group 3 died; and within six days of exposure to infection, 11 animals of Group 4 died.

Post-mortem examinations were made. No internal lesions were found. Deaths were apparently due to septicaemic conditions. From the heart blood of some of the dead animals, growths of gram-positive cocci and gram-negative bacilli were obtained.

Six weeks after exposure to infection, the remaining animals in each group were killed and subjected to careful post-mortem examinations.

Results.—The results were as follow:—

Group 1: 50 animals remained—no lesions.
Group 2: 12 animals remained—no lesions.
Group 3: 17 animals remained—no lesions.
Group 4: 14 animals remained—no lesions.

Comment.—While it would be necessary to confirm the above findings by further tests before arriving at any definite conclusion, it would appear that the dust in the counting-out pens is not a serious source of infection, at least for the guinea pig, although this animal is much more liable to contract caseous lymphadenitis than is the sheep.

(*ii*) *Experiments with Surface Soil from Sheep Camps on Affected Properties.*

Surface soil from sheep camps on each of three affected properties was obtained. In each case, the soil sample consisted of surface dust taken from several camps on different parts of the property.

Group 1: 8 guinea pigs, each of which had previously received a dose of 100 units of veterinary tetanus antitoxin, were closely shorn over the withers. Each received two triangular flap-type wounds, about ½ inch long, extending through the skin and into the subcutaneous tissue. The powdered surface soil from C.'s property was dusted over the wounds; the animals were then placed in separate fly-proof containers.

Group 2: 8 guinea pigs received similar preliminary treatment, and were dusted with soil sample from E.'s property, and were placed in separate fly-proof containers.

Group 3: 8 guinea pigs received similar preliminary treatment, and were dusted with soil from J.'s property, and were placed in similar containers.

Within a few days of treatment, two animals of Group 1, one of Group 2, and one of Group 3, died. (Owing to the absence of the writer, no post-mortem examinations were made.)

Seven weeks after treatment, all animals were killed, and careful post-mortem examinations were made.

Results.—The results were as follow:—

Group 1: 6 animals—no lesions.

Group 2: 7 animals—one showed a large abscess in the spleen, from which a pure culture of a gram-positive coccus was obtained. One showed several small nodules in the spleen, from which pure cultures of (*a*) a gram-positive coccus, and (*b*) a gram-negative bacillus were obtained.

Group 3: 7 animals—no lesions.

2. Infection Tests with Accumulated Faeces from Shearing Sheds where Caseous Lymphadenitis is frequent.

*By H. R. Carne, B.V.Sc.**

(*From the Pathology Department, F. D. McMaster Animal Health Laboratory.*)

Supplies of faeces were obtained from the counting-out pens of the shearing sheds on three properties, on which a considerable incidence of caseous lymphadenitis was known to occur in adult sheep which had been on these properties since birth. Care was taken to collect faeces from pens in which they were sheltered from direct sunlight, as it is known that the latter destroys *Corynebacterium preisz-nocard*† in a few hours.

Sample A was tested on 20 guinea pigs.

Sample B was tested on 20 guinea pigs.

Sample C was tested on 30 guinea pigs.

Ten guinea pigs were used as controls.

The experiment was carried out in the following manner:—

Guinea pigs were run separately in cages made from new kerosene tins. These cages, in addition to having wire-netting tops, were covered by a fine mesh cheese-cloth, and thus rendered fly-proof. In order to protect the guinea pigs from infections by pathogenic anaerobes, which commonly occur in faeces, each animal, except the controls, received 1.0 cc. of a mixture of antisera prepared against *B. welchii, Vibrion septique, B. oedematiens,* and *B. tetani.* The following day, each guinea pig was clipped over the withers, and two V-shaped wounds about 1 to 1.5 cm. long were made in the skin over the withers. Several hours later, when bleeding and exudation from these wounds had ceased, the sample of faeces to be tested, after having been reduced to a coarse powder by passing through a fine mincing machine, was dusted freely on to the surfaces of the wounds and gently rubbed well under the flaps of skin. The floor of the cage in each case was covered with a layer of the same ground-up faeces to a depth of about ½ inch, and this layer was renewed twice weekly when the cages were cleaned. The mash and green feed on which these animals were fed were dropped on to the floor of the cage, there being no containers to prevent the food becoming

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† Also referred to as the "bacillus of Preisz-Nocard," or the "Preisz-Nocard bacillus."

contaminated with the powdered faeces. It was thought that, by doing this, opportunities of infection by ingestion would be added to infection through the wounds.

The process of wounding and contaminating wounds with faeces was repeated on each guinea pig fourteen days after the first wounding. Animals were then kept for one month, when all were killed and submitted to a detailed post-mortem examination.

The ten control animals received no antisera, nor were their wounds dusted with faeces. The floors of their cages were covered with sawdust. Otherwise, they were kept under the same conditions as the test guinea pigs, and were wounded twice at the same time as these.

Particular care was taken to keep the animals fly-free, and when the cages were being cleaned twice weekly, the attendant, after disinfecting his hands, placed the guinea pig whose cage was to be cleaned into a clean cage with a layer of sawdust on the floor moistened with disinfectant. No disinfectant was used in the experimental cages, which were merely scraped out and a fresh supply of ground-up faeces sprinkled on the floor.

Ten guinea pigs died during the course of the experiment, eight amongst the experimental lots, and two controls. In only one of these were any lesions found which bore any resemblance to those produced by *C. preisz-nocard*. This was a guinea pig in one of the experimental lots which accidentally strangled itself on the seventh day after the second dusting by becoming entangled in several loose strands from the cheese-cloth cage covering. On post-mortem examination, the wounds were found to be almost completely healed, and showed no evidence of any undue inflammation. The tissue beneath the wounds appeared quite normal, but the right axillary lymphatic gland was enlarged to about twice its normal size, and was firm and juicy. No abscesses could be detected in its substance, but on culturing pipettes of material taken from the pulp, a mixed culture of diphtheroid bacilli was obtained. One of these organisms was morphologically identical with *C. preisz-nocard*, but on cultural examination it proved to be different. This animal was quite lively and strong before it was killed.

The other 60 guinea pigs remained in vigorous health throughout, and on post-mortem examination a detailed examination of all the lymphatic glands and organs failed to reveal any sign of abnormality in any case, apart from one or two parasitic lesions in the liver. The wounds, in spite of gross contamination with faeces, appeared to heal rapidly in all cases, and a careful examination of the subcutis beneath the wounds failed to show any pathological changes, nor while the animal was alive was definite suppuration detected in any wound during the process of healing.

This experiment thus failed to detect the presence of *C. preisz-nocard* in the three samples of faeces tested.

Note.—The faeces used in these experiments were collected from pens underneath the shearing shed which were protected from direct sunlight. One lot was rather dried up; the others still contained some moisture. The exact date of collection after shearing is not known, but it must have been a matter of a couple of months.

3. Percutaneous Infection of Guinea Pigs and Sheep with Caseous Material from Natural Lesions of Caseous Lymphadenitis.

*By H. R. Carne, B.V.Sc.**

(From the Pathology Department, F. D. McMaster Animal Health Laboratory.)

Four guinea pigs were clipped over the withers with scissors, great care being taken not to injure the skin in any way. The clipped area was then gently inuncted with fresh caseous material from a natural lesion on a sheep. By cultural examination, this lesion was found to contain numerous *Corynebacterium preisz-nocard* in purity. The material was gently rubbed in with the smooth rounded end of a small glass pestle.

Five days later, three of the guinea pigs showed some dried serous exudate on the surface of the skin over the inuncted area. The prescapular and axillary lymph glands draining the treated area appeared normal on palpation. These changes in the skin disappeared in the course of a few days in two of the pigs, but in the third, loss of hair over the affected areas, followed by the formation of small discrete abscesses in the skin and subcutis occurred. One of these abscesses ruptured on the 11th day, and another on the 27th, but several others persisted up to the 46th day, when this animal was killed.

Enlargement of the axillary and/or prescapular lymph glands was observed in three animals. The earliest glandular involvement was observed on the eleventh day, but all three animals showed abscesses in prescapular or axillary lymph glands on one or both sides by the third week.

One guinea pig died on the 33rd day, and the remainder were killed on the 46th day. In all but one animal, which appeared quite healthy, well developed abscesses containing numerous *C. preisz-nocard* in a state of purity were present.

Percutaneous Infection.—The following results were obtained, the experimental sheep being treated similarly to the guinea-pigs:—

(a) With Corynebacterium preisz-nocard.

Culture alone ..	*Sheep.*—One lamb did not become infected. *Guinea Pigs.*—
Culture in lanoline ..	*Sheep.*—One lamb developed two small nodules in the skin. No glandular lesions. *Guinea Pigs.*—
Caseous material from natural lesions ..	*Sheep.*—One lamb did not become infected. *Guinea Pigs.*—Three out of four became infected.

(b) With Corynebacterium pyogenes.

Culture alone ..	*Sheep.*—One lamb did not become infected. *Guinea Pigs.*—Two guinea pigs did not become infected.
Culture in lanoline ..	*Sheep.*—One lamb did not become infected. *Guinea Pigs.*—Two guinea pigs did not become infected.

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The Manganese Content of some Australian Timbers.

By W. E. Cohen, B.Sc., and A. B. Jamieson, M.Sc.**

1. Introduction.

The element, manganese, is known to be distributed universally throughout the plant kingdom and to fluctuate more in amount than do most of the other elements that may be found in plants(1). It generally reaches its highest concentration in the leaves and seeds. Many theories have been advanced with respect to its function, but it is not intended to discuss them in this paper†.

Gössl(2) found that swamp plants and water plants, in general, contain more manganese than do dry land plants, and that the evergreens have a greater quantity than the deciduous trees. It has been stated that the total amount of this element in the plant will vary with the nature of the soil, although Kleinstuck(3), who examined the leaves, bark, and wood of the more important European trees, found its occurrence to be quite arbitrary, i.e., without any relation to the locality, the soil, or the age of the tree.

The manganese contents of the ashes of various timbers have been recorded from time to time. Amounts up to as much as 3 per cent., estimated as Mn_3O_4, have been found in the ash of oak, 4.85 to 7.74 per cent. in that of beechwood, and 10 to 18 per cent. in that of birch. However, in some cases, much lower values are found in these woods. Dittman(4) found that the stemwood of beech was much richer in manganese than the branchwood. The highest recorded value for manganese (Mn_3O_4)—in the ash of *Abies pectinata*—was 40 per cent. Kleinstuck(3) has recorded the manganese content as mgms. of manganese per 100 grams of completely dried material as follows (see Table 1):—

TABLE I.—SHOWING THE MANGANESE CONTENT OF THE LEAVES, BARK, AND WOOD OF THE MORE IMPORTANT EUROPEAN TREES. (MGMS. OF MN. PER 100 GMS. OF COMPLETELY DRIED MATERIAL.)

Tree.	Stem Wood.	Bark.	Leaves or Needles.
Pine	9·2	53·1	16·1
Fir	1·1	11·1	27·5
P. sylvestis	11·9 (pith)	17·2	35·0
Larch	18·9 (pith)	4·4	74·8
Oak	0.03 (pith)	28·0	41·6
,, ...	4·4 (sap)	..	..
Red beech	16·4	112·0	94·5
Hornbeam	8·0	345·2	158·2
Birch	0·7	6·5	67·0
Maple	1·3	12·6	90·3
Linden	1·7	11·0	10·3
Ash	0·8	3·1	1·8
Alder	1·2	7·7	3·7
Poplar	2·1	12·5	5·4

* Officers of the Division of Forest Products.

† It might be mentioned, however, that an interesting instance of the effect of a lack of manganese occurs in South Australia, where in certain parts barley cannot be successfully grown until the soil has been given a small application of manganese sulphate.

With reference to Australian timbers, Baker and Smith(5) recorded the manganese content of the ashes of a number of Australian pines, and discussed the association of this element with the exudations from these trees. They stated that for all the conifers of Australia that they had tested, the element proved to be a necessary constituent for the best growth of the trees. Simpson(6) observed that the ash of salmon gum (*Euc. salmonophloia*) is unusually rich in manganese, the ash of the branches containing over 3 per cent. Mn_3O_4, while that of the main trunk contains 2.5 per cent. Tuart (*E. gomphocephala*) contains about 1.5 per cent., while karri (*E. diversicolor*) and jarrah (*E. marginata*) contain less than 1 per cent. expressed as a percentage of the ash.

2. Recent Observations of the Occurrence of Manganese in Australian Timbers.

(i) *Tasmanian Myrtle* (*Nothofagus cunninghamii*).—During the determination of the alkalinity of the ash (7, 8) involved in a study of chemical differences between the sapwood, intermediate wood, and truewood of Tasmanian myrtle (*Nothofagus cunninghamii*), a high percentage of manganese was suspected, for on the dissolution of the ash in dilute acid there developed a pink colour which interfered with the back titration of the excess acid using phenolphthalein indicator.

A procedure, briefly described below, was employed in order to determine the manganese content of samples of sapwood, intermediate wood and truewood taken from three cross sections of the bole of a tree, viz., butt, mid-log, and top. The results were expressed in terms of milligrams of Mn_3O_4 per 100 grams of oven-dried (105° C.) wood. This method of expression has been adopted because experience has shown that results expressed as a percentage of the ash are inconsistent, and cannot be duplicated with any great measure of accuracy. The manganese contents of the sapwood and intermediate woods were found to be much the same, varying from 10.7 mgms. to 14.9 mgms., these extremes both occurring in the intermediate wood. In the same tree, the truewood contained from 6.4 to 9.4 mgms. On the examination of two further cross sections taken from another and larger tree, the manganese content of the sapwood and intermediate wood ranged from 4.53 to 6.23 mgms., while that of the truewood varied from 1.88 to 4.45 mgms. Although little value can be placed on results expressed as a percentage of the ash, the following figures are quoted in order to afford a comparison with figures for other woods already expressed in this manner. In the first tree, the manganese content of the ash of the sapwood and intermediate wood varied from 2.4 to 4.7 per cent., while that of the truewood ash ranged from 2.7 to 4.5 per cent. In the second tree the ranges were from 0.8 to 1.1 per cent. in the ash of the sap and intermediate woods, and from 1.1 to 1.9 in the truewood ash.

With reference to the supposed relation of manganese to the extraneous materials contained in some woods, the following results are of interest. The wood of Tasmanian myrtle is found in two types, the white and the red. The trees producing these two different types of wood may grow alongside one another. Samples of the white type were found to contain from 7.55 to 8.50 mgms. of manganese per 100 grams of oven-dried wood, while those of the red type were found to

vary from 5.53 to 11.45 mgms. From this, it would appear that the manganese is not directly associated with the colouring substance in the red wood.

(ii) *Eucalyptus crebra and Eucalyptus salmonophloia.*—Macroscopic and microscopic studies of truewood samples of a number of coloured woods of the genus *Eucalyptus*(9) have revealed that the woods of narrow-leaved ironbark (*E. crebra*) and salmon gum (*E. salmonophloia*) are in some instances difficult to separate by such examinations. Chemical studies have been undertaken in order to afford some definite means of separating these two woods, and, in view of Simpson's observations on the unusually high manganese content of salmon gum(6), determinations of manganese in truewood samples of these two woods were made. In ten samples of *E. crebra,* the manganese content varied from 0.94 to 3.05 mgms. of Mn_3O_4 per 100 grams of oven-dried wood (or from 0.3 to 2.1 per cent. of the ash). In the twelve samples of *E. salmonophloia* examined, the manganese content was found to vary from 2.59 to 40.2 mgms. (or from 0.5 to 6.6 per cent. of the ash). In each species, all samples were obtained from butt logs of different trees. Although the results showed that the manganese content was not a reliable diagnostic feature, they served to indicate the extensive variation that may be expected in a species, and hence the danger of quoting results based on the examination of too few samples. Most of the ashes of *E. salmonophloia* samples contained less than 1 per cent. of Mn_3O_4, and except for two cases, i.e., 6.6 and 4.4 per cent., the manganese content of this wood was not unusually large.

(iii) *Occurrence in other Eucalypts.*—The closely related woods of the ironbarks, *E. sideroxylon, E. siderophloia, E. crebra, E. paniculata,* and *E. fergusonii,* and of the grey gums *E. propinqua* and *E. punctata* have been studied by means of a standardized qualitative procedure with the object of indicating any unusual occurrence of one of the elements generally found in wood. Manganese has been shown to be present in all these woods; to a small extent in the woods of *E. sideroxylon, E. siderophloia, E. crebra,* and *E. paniculata,* to a somewhat greater extent in the woods of *E. propinqua* and *E. punctata,* and to a still greater extent in the wood of *E. fergusonii.* At a later date it is proposed to examine these woods quantitatively with the object of using the determination as an aid to identification.

3. Procedure Employed for the Determination of Manganese.

The determination of manganese was carried out in duplicate in the following manner:—Five to 10 grams. of oven-dried wood splinters (amount depending on the species) were weighed accurately into a platinum dish. The wood was ignited for one hour at about 600°C., the position of the duplicate samples in the muffle furnace being reversed at the end of the half-hour in order to ensure a uniform air supply. The ash was cooled in a desiccator, moistened with water, and a few drops of concentrated sulphuric acid, followed by 1-2 cc. of hydrofluoric acid, were added. The dish and its contents were heated, very cautiously at first, later more strongly, and finally the sulphuric acid was fumed off. This treatment was repeated, care being taken not to

continue heating after fuming had stopped, as the more difficultly soluble oxides could be formed. The above process removed all silica, some of which has been shown to occlude manganese compounds(10).

Concentrated sulphuric acid (2.5 cc.), glacial phosphoric acid (0.5 cc.), and water (10 cc.) were then added, and the dish and its contents heated on a boiling water bath until all the material was dissolved. The whole was transferred to a 100 cc. beaker using sufficient water to have approximately 50 cc. of solution, i.e., 6 per cent. of acid present(11). Potassium periodate (0.3 gram.) was added, the solution boiled for 2 minutes and then heated on the boiling water bath for 20 to 30 minutes. After cooling, the solution was made up to 50 or 100 cc., depending on the colour obtained, and compared in the colorimeter with a standard solution of potassium permanganate prepared by the oxidation, in a similar manner, of manganese sulphate. Blank determinations were made on every occasion, but were entirely negative.

4. Summary of Results.

The study of samples of Tasmanian myrtle (*Nothofagus cunninghamii*) has revealed that, in any one tree, there exist differences in manganese content between sap and intermediate wood on the one hand, and truewood on the other. These differences are not constant for the species, e.g., in two trees the manganese content of the sapwood of one may not be very different from the content of the truewood of the other. This indicates an irregular occurrence of the element, but it may be stated that manganese can occur in fairly large quantities in this timber.

A similar irregular occurrence was observed in the case of some samples of salmon gum (*E. salmonophloia*), but in most cases the content could be described as a normal quantity. If the irregular occurrence of manganese in these species is typical, the possibilities of using the determination of the element as a diagnostic feature are very remote. The examination of Australian timbers to date has supported the statement that manganese is of universal occurrence in timber.

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Compression Wood in Hoop and Bunya Pine.

*By H. E. Dadswell, M.Sc., and I. Langlands, B.E.E.**

1. Introduction.

In the work of the Division of Forest Products on the better utilization of Australian timbers, a recent problem connected with blind rollers made from hoop pine (*Araucaria cunninghamii*) and bunya pine (*Araucaria bidwillii*) is of general interest. A number of these rollers, which were mainly 39 to 42 inches in length, and 15-16 inch in diameter, showed a definite bend or spring sufficient to render them unfit for service; such faults developing after the articles have been manufactured form a definite source of loss to the manufacturer, and this loss is sufficient to prevent competition with imported rollers. In order to reduce or eliminate this source of loss, the Division was requested by the manufacturer concerned to investigate the causes of such bending in the rollers.

The bend was found to be due to a greater longitudinal shrinkage of the wood on one side of the roller. There are several possible causes for this shrinkage, of which the following were considered the most probable under the circumstances:—

(1) The presence of sloping grain. In a piece of wood with sloping grain, i.e., in a sample in which the grain does not run parallel to the long axis in all parts of the piece, there may be an apparent longitudinal shrinkage which is in reality a component of transverse shrinkage. When sloping grain is present to any extent in a board or stick which is subsequently dried, transverse shrinkage will exert an influence on the length of the piece, and bending will result if the sloping grain is localized on one side. In the case of a number of rollers examined, the bending was due to such a cause. If care is exercised in milling and manufacture, bad shrinkage effects due to sloping grain should be eliminated before the article is completed.

(2) The presence of growth abnormalities in the wood. A common abnormality, which causes excessive longitudinal shrinkage, is known to saw-millers of the Northern Hemisphere as "compression" wood. The longitudinal shrinkage (i.e., shrinkage along the grain) of normal wood is comparatively small, and ranges from 0.1 to 0.3 per cent. when the timber is brought from a green state to the oven-dry state. However, cases have been observed in which the shrinkage along the grain was abnormally large—in one case up to 5.78 per cent.(1). These cases of abnormal shrinkage have been shown to be due to a peculiar type of wood called "compression" wood. Thus, if bands of "compression" wood were present on one side of a board, and drying occurred, one would naturally expect the longitudinal shrinkage to manifest itself, and to cause the bending of the board.

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Some dark bands of wood were present in many of the rollers examined, and it was considered probable that these were indicative of "compression" wood. Before describing tests by which such impressions were confirmed, it will be advantageous to consider what is known of "compression" wood, its formation, and its properties.

2. Description of Compression Wood.

Australian timber users, in general, are not familiar with compression wood, although they have probably noticed the irregular and dense bands of wood in pines, spruce, hemlock, and redwood. The name given to these denser bands of abnormal wood has been based on the fact that they are found commonly on the lower or compression side of branches and leaning trees(2). Other names which refer to this abnormal wood are "rotholz" (redwood), "proud wood," "timber bind," and "hard grain." According to Burns(3), it is generally accompanied by eccentric growth, and this has been substantiated by observations on Northern Hemisphere conifers.

The formation of compression wood was explained in general by Burns(3) as being due to one or more of the following causes:—

(1) The wind, which acts as a mechanical stimulus resulting in a compression on the leeward and a tension on the windward side, the tree forming its greatest growth as well as compression wood on the compression side.

(2) Differences in illumination on north and south sides.

(3) Differences in branching, and hence better nutrition on the branched side.

(4) Gravity acting as a stimulus.

Experiments in which compression wood was artificially produced in small trees were carried out by Burns, and as a result its production was considered to be a response to gravitational stimulus.

Büsgen(4) states that in cases of artificial production by the bending of branches or stems, the concave side of the bend is compressed, the convex side is under tensile strain, and the pressure acts as a stimulus to the formation of compression wood. The same stimulus is also considered to be the cause of its formation on the compression side of trees exposed to the wind. However, in a leaning tree, the formation of compression wood is generally ascribed to gravitational stimulus, and this could account for its presence on the underside of branches and leaning stems.

While its occurrence is fairly common in softwoods or coniferous woods, i.e., the spruces, firs, pines, hemlocks, and other species of the Northern Hemisphere, the same type of structure has not been reported for the hardwoods (oaks, ashes, hickories, eucalypts, &c.). Although up to the present it has not been reported, abnormal growth of the same nature as "compression" wood does occur in the trees of Australian coniferous species. For this reason, a brief *résumé* of the known properties of compression wood is given below, and this necessarily refers to observations made on coniferous timbers of the Northern Hemisphere.

The most outstanding property of compression wood is its tendency to shrink along the grain to a much greater extent than normal wood, thus causing bowing, splitting, and twisting in boards containing it.

On an end section of a log or board, it is generally recognizable by the rather wide growth rings containing a large proportion of dense late wood which is darker in colour. This greater width of growth rings, in comparison to that of normal wood, is accompanied by eccentric growth. That is to say, on the compression side of the log, the distance from pith to bark is greater than on the other side. This is demonstrated in Fig. 1.* Sometimes, there is no clear line of demarcation between compression wood and normal wood, and the two grade into each other imperceptibly. Thus, no fixed value for the longitudinal shrinkage of compression wood can be found, although, for species examined, it is greater than 0.3 per cent., and often as much as 1 per cent. and more.

The compression wood is generally much denser than the normal wood of the same growth ring, and in comparison with normal wood from the same tree, its mechanical properties are variable, even when allowance is made for the difference in density. It has been assumed that the wood formed in response to compression should be specially strong in compression, and that tension wood should similarly excel in tensile strength, yet various figures have appeared from time to time which appear to show that this is not necessarily the case(5). The relative properties of normal wood and compression wood apparently differ greatly with the species, the property under consideration, the moisture content, and the severity of compression wood. As far as can be judged on available data, compression wood is deficient in modulus of elasticity, i.e., it has a low stiffness, in comparison with normal wood; even when higher in strength, it also shows a brittle fracture when tested in cross bending.

Under the microscope, there are several features which are indicative of compression wood. The cells are nearly circular in cross section in comparison with the typical rectangular or polygonal shape of the cells of normal wood, and in addition they are often separated by intercellular spaces instead of being completely joined one to another(6). Microscopical examination of longitudinal sections also reveals the presence of spiral checks or striations in the cell walls of the tracheids of the compression wood(6). Such spiral checks are not present in tracheid walls of normal wood.

While the amount of softwood timber containing compression wood is a considerable proportion of the total amount milled in America, that causing serious trouble in utilization is readily recognizable(2). It is thus eliminated as far as possible in building construction, or in other places where its excessive longitudinal shrinkage may cause trouble (such as in the bowing or sagging of beams, in bending, splitting, and twisting of boards, or in any product where the use requirements are exacting).

3. Compression Wood in Australian Timbers.

While the Division of Forest Products has not yet made a definite survey of the occurrence of compression wood in Australian pines, it has been recognized that it may be fairly common. For instance, certain boards of hoop pine are known to spring right out of the drying stacks; others twist and warp in drying; and others develop a pronounced bow. These characteristics in softwoods are typical of timber containing

* See Plate I. facing page 124.

compression wood. It is also known that millers express a preference for hoop pine logs from straight trees growing in flat sheltered areas, while the timber from trees growing on hillsides is disliked. They have no reason for such preference, except that the timber behaves better in milling and drying. Logs from certain hillside trees often show eccentric or off-centre growth, and timber from these logs misbehaves badly during milling and drying.

It is apparent, therefore, that many products made from Australian "pines" may contain compression wood, and this is likely to cause trouble in those products in which requirements are exacting. Thus, in the case of the blind rollers, where straightness is essential, many were found to be bent owing to the presence of bands of compression wood. This was recognizable macroscopically on the longitudinal face, although it was not easy to distinguish on the cross section, owing to the small area available for examination. A microscopic examination of the dark-coloured bands of wood definitely confirmed the opinion that it was compression wood, as the cells on the cross section were circular in shape, intercellular spaces were common (see Fig. 2), and spiral checks were observed in the cell walls of the tracheids (see Figs. 3 and 4). The longitudinal shrinkage of the dark band of wood was also determined, and found to average 1.5 per cent. in comparison with approximately 0.1 per cent. shrinkage for normal wood.

It is of interest to note that a blind slat of New Zealand white pine examined by the Division also showed a definite bend, due to the presence on one side of a distinct band of compression wood, which was darker in colour than the normal wood in the same slat. Here, again, microscopical examination revealed the typical characteristics of compression wood, the line of demarcation between normal and compression wood being very marked, while the longitudinal shrinkage of the compression wood was much greater than that of the normal wood.

A piece of hoop pine 4 inches x 4 inches in cross section, which was received from New South Wales for experimental purposes, showed a definite band of compression wood, approximately 1½ inch in width on the quarter face. This had caused a distinct bend in the length of the piece, due to greater longitudinal shrinkage. In Fig. 5, the general appearance of this band of compression wood on a freshly cut cross section is shown. In this sample, there was abundant material for several comparative tests. The *basic density* of samples from both compression wood and normal wood was determined according to standard procedure (on basis of oven-dry weight in grams and volume in c.c. when soaked to maximum volume) with the following results:—

	Basic Density.
Normal wood—	
Average of five determinations on wood from different areas	26.8 lb./cu. ft.
Compression wood—	
Average of two determinations on wood from different areas	35.5 lb./cu. ft.

The compression wood was, therefore, 1.33 times as dense as the normal from the same stick. The basic density of the normal wood was within the recorded range for samples of this species, namely, 26-34 lb./cu. ft. (average 29 lb./cu. ft.).

The toughness of sticks taken from both normal and compression wood was determined according to standard procedure. Four sticks of each kind of wood were tested, the average moisture content of each stick being 15 per cent. The toughness of the compression wood was higher (40 inch-lb./cu. in.) than that of the normal wood (28 inch-lb./cu. in.), but was not as high as would be expected from its greater density(7). Each of the four sticks of compression wood showed a distinct brittle failure in comparison with the more splintering failure of the normal wood. The greater longitudinal shrinkage of the compression wood was also demonstrated.

4. Conclusions.

From the few tests carried out, it is apparent that the compression wood found in Australian "pines" is similar in appearance, properties, and structural characteristics to that of the softwoods of the Northern Hemisphere. Thus, it is well for timber users to take note of its existence, and of its characteristic properties. For many purposes, its presence does not seriously affect the timber, but for any application in which requirements are exacting, it should be eliminated. This can best be done by careful selection. It is preferable to examine the freshly cut cross sections of logs, and to determine as far as possible the extent of compression wood, if any, in these logs. When milling for special products, the areas containing compression wood can be avoided, but boards which contain such wood need not be considered waste, as slightly bowed or twisted pieces are quite satisfactory for many uses.

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PLATE I.

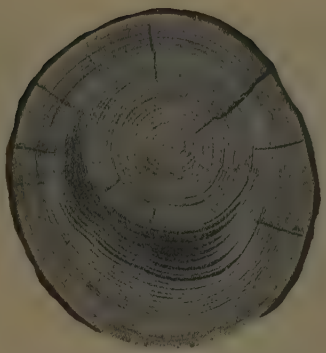

FIG. 1.—A cross section of a spruce log showing eccentric growth and bands of compression wood—the dark wide bands on the lower side.

Manual for the Inspection of Aircraft Wood and Glue for the U.S. Navy, p. 20].

FIG. 2.—A cross section of *Araucaria bidwilli* (Bunya Pine) magnified 100 times—the upper cells are thick-walled, rounded in shape and in many cases separated from each other by intercellular spaces which can be readily seen, these features are typical of compression wood—the lower cells are more typical of normal wood, being large and angular in shape.

PLATE II.

FIG. 3.—A radial section of *Araucaria bidwilli* (Bunya Pine) normal pine wood, showing arrangement of pits. 100 × cf. Fig. 4.

FIG. 4.—A radial section of *Araucaria bidwilli* (Bunya Pine) showing spiral checks in cell wall radiating from the pits—these checks are not common in normal wood (cf. Fig. 3) and are characteristic of compression wood. 100 ×.

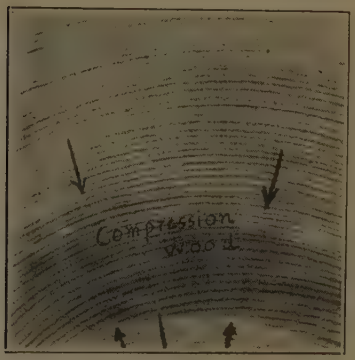

FIG. 5.—A cross section of a block of *Araucaria cunninghamii* (Hoop Pine)—one-half natural size—showing dark band of compression wood in contrast with normal wood.

NOTES.

Requests for Publications by Predecessors of the Council.

From time to time the Council for Scientific and Industrial Research is asked for copies of the various publications of the two bodies, namely, the Advisory Council of Science and Industry and the Institute of Science and Industry, which preceded it. Unfortunately, a number of these publications are out of print, and it is thus quite impossible for the Council to meet these requests.

Sometimes, too, requests are received from important libraries which are desirous of maintaining their sets of Council publications complete and which occasionally find that such sets lack a number or two. For instance, the Fisher Library of the University of Sydney is very desirous of having a copy of Bulletin No. 6—"Power Alcohol: Proposals for its Production and Utilization in Australia," issued in 1918.

In a country of such large distances as Australia, it is obviously of importance to maintain the contents of the various libraries in as complete a form as possible. It has accordingly been thought that if the foregoing position were generally known, some people who possess back copies of the publications in question, and who have no further use for them, would be only too glad to let the Council have them for transmission in turn to libraries or other people who want them.

The publications which are particularly desired are the following:—

Bulletins Nos. 1 (cattle tick), 2 (worm nodules), 3 (alunite), 4 (Bendigo Goldfield, Part I.), 5 (wheat storage problems), 6 (power alcohol), 7 (agricultural research), 8 (Bendigo Goldfield, Part II.), 9 (ferro-alloys), 14 (Posidonia fibre), 18 (wheats), 20 (power alcohol), 21 (white ants), and 26 (wheats).

Memoir No. 1. "The Australian Environment (especially as Controlled by Rainfall)" by Griffith Taylor.

Publications of the Council.—The Method of Distribution.

It has recently become evident that a brief description of the way in which the Council's publications are distributed would be of some value.

The publications in question may be classified into the Annual Reports, Bulletins, Pamphlets, and the *Journal*. A number of all these are distributed on a general mailing list which includes important libraries and scientific organizations not only in Australia, but throughout the world.

The main sources from which the Council's research information may be obtained are the Bulletins, Pamphlets, and the *Journal*. Each copy of the last-named being likely to contain articles of interest to different kinds of research workers, its distribution is fairly wide.

Each Bulletin and each Pamphlet, however, is confined to one subject, and any particular issue is thus of interest to one or two classes of research workers only. For that reason, both these series are distributed according to special lists. Thus, if an organization deals only with soils, it is sent only those Bulletins and Pamphlets which are likely to have a bearing on its work, and it is not sent those Bulletins and Pamphlets on other aspects of the Council's work, for example, forest products. Accordingly, some organizations and individual recipients would by no means have complete sets of these two series. On the back of the cover of each individual number, however, a complete list of the series issued to date is given. If, therefore, any libraries, scientific organizations, or individuals find that they have missed particular numbers of interest to them, those numbers will be forwarded promptly if they care to acquaint the Council with their desire.

Finally, each copy of the *Journal* contains a brief review of the publications that have become available since the previous issue of the *Journal*. One of the objects of these reviews is that the daily and technical press may use them to acquaint the general public with what material is available.

A Simple Chemical Test for Separating the Woods of Hoop Pine (Araucaria cunninghamii) and Bunya Pine (Araucaria bidwilli).

(Contributed by W. E. Cohen, B.Sc., Division of Forest Products.)

In the timber industry, cases frequently occur where it is very desirable to have a ready means of distinguishing between two or more closely allied timbers. The separation of the woods of hoop pine and bunya pine is such a case. Although the trees of these two species are very different, the woods are very much alike in appearance and structure. In certain cases, it is claimed that bunya pine wood has a pinkish tinge, but, as this is not general, such an observation cannot be used as a distinguishing characteristic.

With the object of finding a simple distinguishing test, the Division of Forest Products has made a comprehensive study of the structural and chemical features of the two woods. Macroscopic and microscopic examinations have failed to reveal any constant structural differences. The chemical study has been confined to the examination of the aqueous and alcoholic extracts of the woods with the application of numerous simple chemical tests for sugars, acids, resins, &c. As the result of this work, the simple chemical test described below has been developed.

The test is applied to the aqueous extracts which are prepared as follows:—

Rasped samples of the woods are prepared and the material which passes through a 20-mesh sieve is used. Five grams of this material (if air dry) is placed in a flask fitted with a reflux condenser, and extracted for two or three hours, at the temperature of a boiling water bath, with 50 cc. of water. After filtering and pressing the residual

wood, the latter is washed with 50 cc. of boiling water, the wash being added to the original extract. When cool, the volume of the extract is adjusted to 100 cc.

To 2 cc. of the aqueous extract, contained in a roomy test tube, 1 cc. of concentrated sulphuric acid is added to form a layer. The layers are mixed by gently shaking the test tube.

In the case of bunya pine, a pink colour will develop immediately, and an orange (harvest) coloured precipitate will form (sometimes slowly). With hoop pine, there will be no immediate colour change, but later a white gelatinous precipitate will form.

The observation of the pink colour has been found to be more reliable than that of the subsequent precipitate. In many cases the aqueous extracts of bunya pine are more deeply coloured (light orange) than those of hoop pine. Although this cannot be claimed to constitute another test, it can generally be used to give a fairly reliable indication. Naturally, in such cases, the pink colour mentioned above will then be orange pink. The test has been found to give the above differences when applied to 21 out of 22 samples of bunya pine and to 26 samples of hoop pine, all from individual trees. The defaulting bunya pine sample resembled hoop pine in many ways, and its origin is being further investigated.

An additional test which may be used in most cases, for confirmatory purposes only, is applicable to the alcoholic extracts prepared in a manner similar to that already described for the aqueous extracts. The procedure is as follows:—

To 2 cc. of the alcoholic extract, contained in a roomy test tube, add five drops of diphenylamine solution (20 per cent. alcoholic) and then 2 cc. of concentrated sulphuric acid to form a layer. Mix the layers by carefully shaking the test tube for about one minute, and then examine the resultant colour.

With bunya pine extract, the colour will be reddish brown. With hoop pine extract, the resultant colour will be light orange.

This test has given the above differences when applied to 21 out of 22 samples of bunya pine (the defaulting sample being the one already mentioned) and to 23 out of 26 samples of hoop pine. Hence, in most cases, it could be used as a confirmatory test, but the results obtained should not be permitted to reverse the deductions which have been drawn already from the test applied to the aqueous extract.

The Greenhouse White-fly in Tasmania.

The Greenhouse White-fly, *Trialeurodes vaporariorum,* is a serious pest in hot-houses in Tasmania, and particularly affects the growing of early tomatoes. Chemical treatment of this pest is difficult, and it has for some time been recognized that the best way to deal with it is by means of biological control.

In England, the tropical parasite *Encarsia formosa* has been found to be quite successful in hot-houses which are kept warm throughout the winter months. This parasite is a tiny Chalcid wasp, very susceptible to cold. It lays its eggs in the tests of the white-fly, which

turn black when parasitized, owing to the parasitic grub destroying the white-fly nymph under the test and then turning into a blackish pupa.

So far, all attempts to establish this parasite in lands south of the Equator have failed. Consignments carried in cool store are so weakened by the prolonged exposure to cold weather that they either arrive with every individual parasite dead, or, at best, they only yield a few weakly individuals from which it would be most unwise to attempt to rear a new generation.

The first consignment of *Encarsia* from England received from Mr. S. Garthside, who is an officer of the Council's Division of Economic Entomology, and who is working at Farnham Royal, arrived in Canberra in time for Dr. R. J. Tillyard to bring them to Launceston during a visit to Tasmania in January last. They were then placed in a special rearing cage under the charge of Mr. H. Turner, Horticulturist, Tasmanian Department of Agriculture. Only three or four weakly individuals emerged from the consignment over a period of one month from its reception, and none of these lived very long. Though this consignment was a failure, other methods will now be tried whereby the prospects of success will be much enhanced. With the co-operation of Mr. Turner and the tomato-growers of the Launceston district, it is hoped to establish this parasite in Tasmania during the coming spring or summer. It will be most important to make sure of a continuous supply of white-fly during the winter and early spring in the hothouses.

Physiology of Wheat in Relation to Grain Filling.

A Note on the Literature.

In an article[1] in the last number of this *Journal*, on "The Physiological relations between Tillers of a Wheat Plant," it was indicated that the finding, that the glumes of wheat contribute less than 40 per cent. of the dry weight of the grain, was contrary to findings by Boonstra. The statement of Boonstra's results was quoted from an abstract. Since then a translation of his paper has been received from the Imperial Bureau of Plant Breeding, and this is found to modify the abstract. He states, without quoting figures, that "probably the glumes play a great part in the formation of the carbohydrates for the grains." He continues: "The assimilation of the leaves (lamina) in the last period (from flowering onwards) does not amount to more than ± 25 per cent. of the total grain weight." His findings therefore agree very closely with those of Smith, whose estimate of the proportion of grain weight supplied by the leaf blades was 25 and 22.5 per cent. in 1930 and 1931 respectively. Boonstra's work has been published in more detail elsewhere[2, 3], but this paper, like the original of the one quoted, is not yet available in Australia.

1. Smith, H. F. This *Journal* **6**: 32–42, 1933.
2. Boonstra, A. E. H. R., *Der Züchter* **3**: 345–52, 1931.
3. ——————— Med. Landbouwhoogeschool, Wageningen, **33**: (3), 1929.

Peg-Leg in Cattle.

In a previous note (this *Journal*, **5**: 263, 1932), it was mentioned that one of the problems which the Research Station at Townsville is investigating is that of "peg-leg" of cattle. Mention was also made of the small field station for peg-leg studies that has been established at "Helenslee," near Charters Towers, as a result of the co-operation afforded by local cattle-owners.

The precise cause of peg-leg is still obscure, although there are indications that it is due to some deficiency, possibly phosphorus. The symptoms are emaciation, arthritis, fragile bones, arched vertebral column, hooked neck, and stiffness in the gait. Ultimately, the death of the animal ensues, and there is no doubt that peg-leg is responsible for considerable losses in North Queensland each year.

With a view to obtaining as much information as possible regarding the trouble as it occurs in the field, Mr. R. B. Kelley, B.V.Sc., the Field Officer attached to the Townsville Station, last year spent some time visiting various cattle stations in the affected areas. The paragraphs that follow are based on his observations. It should be mentioned, however, that his visit took place in a dry time, and after the country had suffered at least two dry years.

In general, the incidence of the condition was higher in the areas of poorer country (10 head per square mile), but in exceptionally dry times it is also found on better country (20 head per square mile). In parts, the trouble is of comparatively recent origin, as on one large station, of a carrying capacity varying from 10 to 20 or more head per square mile, it was not noticed until about the year 1924.

Due attention was paid by Mr. Kelley to yearly rainfalls and calving percentages, but owing to the extent of the runs (some are 2,000 square miles in extent) it was often quite impossible to estimate these percentages from the data available.

Further, the number of females is only approximately known, except in the years when bang-tail mustering occurs, and frequently this number includes heifers below breeding age. The cows calve all the year round.

In places, it was evident that there was a vicious cycle—dry times and little feed, a calf at foot, and resultant low condition of the dam. These low-conditioned, wet cows merged into those showing all the signs of peg-leg., e.g., some arching of the back, concavity on the dorsal surface of the neck, and stiffness in the gait. If the calved are weaned at this stage, it is not uncommon for the cows to "hold their own" until the feed improved. In some cases, the cows even put on condition with the available food. If, however, they still suckle the calf, as they must, perforce, where weaning is impracticable (open herd conditions) the humped back and stiff gait become progressively more pronounced and typical cases of peg-leg result.

There was some evidence that young breeding cows showed the most mortality. Of the cows examined post-mortem, all those which were advanced cases of peg-leg proved not to be in calf. Their ovaries were relatively small in size; the Grafian follicules, though in cases multiple, were neither cystic nor was there one more advanced than the others. Mr. Kelley proceeds:—"As has been indicated, I have not, as yet, visited

a property where data were available from which to determine calving percentages, but the whole set-up of the cycle, dry feed, low condition, laziness (disinclination to breed) in the males, almost atrophic ovaries in those females which are advanced cases, leads me to think that the condition, or perhaps more correctly these conditions, do play an important part in decreasing the annual drop of calves."

In another case, Mr. Kelley reported:—"The area over which the cattle were spread, the mixed nature of the herd, and their uniformly low condition, made a numerical estimation of the incidence of peg-leg extremely difficult, but in one run of 40 miles through three watering areas, during which a representative sample of the herd should have been seen, I considered that the aged breeders were low in condition, and that 30 per cent. had peg-leg, while among cows 2½ to 4 or 5 years of age, the incidence was 80 per cent. or 90 per cent. Cases of peg-leg were seen among 1930 and 1931 calves, and among the 1932 calves many appeared to be motherless and in very low condition."

Due attention was also paid to goats and indigenous animals. As regards the former, in places a peculiarity in the gait reminiscent of peg-leg was seen. For instance, goats when moving were noticed to have well-developed knee action, the carpus being distinctly flexed as the fore-leg was elevated, and as the upper arm was extended, the metacarpus was brought sharply out and in line with it before the hoof touched the ground—almost a goose-step action. Here again, however, the indications were that the condition was most prevalent in those animals subjected to the strain of reproduction, e.g., Mr. Kelley states:—"Three goats, all females, though in good condition (particularly the dry seven-year old goat killed, and the youngest goat, about eighteen months old, also dry) moved without this almost exaggerated knee action. The condition of the third goat was compatible with her period of lactation and her age, which was nine or ten years. The owner says that from time to time this gait has been noticed generally in the older goats."

One or two kangaroos were examined post-mortem, and once again there were indications—admittedly slight ones—that the animals were not unaffected through some deficiency. For instance, the difference in the ratio between the diameter of the medullary cavity of the tibia to that of its greatest outside diameter was marked in the two sexes. The annulus of bone in the adult male tibia appeared thicker and denser than that of the female. These differences may possibly be connected with a deficiency intensified in the case of the female by the strain of reproduction. A number of tibia were accordingly collected from males and females, the latter carrying young at various stages of development, and these will be examined in the laboratory at a later stage.

However, the grazing habits of kangaroos are vastly different from those of cattle. They are freely mobile, and by reason of the formation of their teeth, eschew long grass, and are found most frequently where the grass is green, short, and succulent. These selective grazing habits are reflected in the contents of their alimentary canals, which Mr. Kelley found uniformly much greener than those of the cattle found in the same paddocks. Seeing, as is well-known, that the mineral content of young grass is much higher than that of the older material, kangaroos would naturally not be subjected to such mineral starvation as would the cattle.

The Imperial Agricultural Bureaux.

The Executive Council of the Imperial Agricultural Bureaux has issued its third annual report (for 1931-32). It will be remembered that the creation of the bureaux was the outcome of the Imperial Agricultural Research Conference, 1927, which recommended the establishment of eight bureaux to collect, collate, and disseminate information on research in certain branches of agricultural science, and to assist workers in these branches to form contacts with other workers.

The Conference also recommended that each bureau should be located at an institution already well known for research in its particular branch, and that the cost of the bureaux should be met from a common fund formed by contributions from Empire Governments. The scheme was subsequently accepted by the Governments, and came into operation on the 1st April, 1929.

The following are particulars of the eight bureaux which have been established:—

Bureau.	Location.	Direction.	Australian Correspondent.
Animal Nutrition	Rowett Research Institute, Aberdeen	Dr. J. B. Orr; *Deputy*—Mr. H. Crow	Sir Charles Martin, Chief of Division of Animal Nutrition (C.S.I.R.), Adelaide
Animal Genetics	Animal Breeding Research Department, Edinburgh University	Professor F. E. Crew; *Deputy*—Dr. F. Fraser Darling	Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne
Fruit Production	East Malling Research Station	Mr. R. G. Hatton; *Deputy*—Mr. D. Akenhead	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra*
Soil Science ..	Rothamsted Experimental Station, Herts	Sir John Russell; *Deputy*—Mr. G. V. Jacks	Professor J. A. Prescott, Chief of Division of Soil Research (C.S.I.R.), Adelaide
Plant Genetics (Herbage Plants)	Welsh Plant Breeding Station, Aberystwyth	Professor R. G. Stapledon; *Deputy*—Dr. R. O. Whyte	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra
Plant Genetics (Plants other than Herbage)	Plant Breeding Institute, Cambridge	Sir Rowland Biffen; *Deputy*—Dr. P. S. Hudson	Dr. B. T. Dickson, Chief of Division of Plant Industry (C.S.I.R.), Canberra
Agricultural Parasitology	Institute of Agricultural Parasitology, St. Albans	Professor R. T. Leiper; *Deputy*—Dr. B. G. Peters	Dr. I. Clunies Ross, Parasitologist, Division of Animal Health (C.S.I.R., Sydney
Animal Health ..	Veterinary Research Laboratory, Weybridge	Dr. W. H. Andrews; *Deputy*—Mr. W. A. Pool	Dr. J. A. Gilruth, Chief of Division of Animal Health (C.S.I.R.), Melbourne

* Deputy Correspondent, Mr. W. M. Carne, Senior Plant Pathologist, Division of Plant Industry (C.S.I.R.), Hobart.

The first year of the bureaux's existence was largely occupied in organization. In their second year, the presence in London of a number of scientific officers from the Empire overseas as advisers to

their Governments at the Imperial Conference, 1930, afforded an opportunity for discussions on the work of the bureaux. In the course of these discussions the scientific advisers urged those bureaux which had started abstracting journals to enlarge them and others which were contemplating them to start them forthwith.

The year 1931-32 was thus the first year in which practically all the bureaux have been issuing journals, and this work has occupied much of the attention of the bureaux's staffs. The journals issued are:—

1. The *Veterinary Bulletin*, issued monthly from Weybridge.
2. *List of Publications relating to Soils and Fertilizers*, issued monthly from Rothamsted.
3. *Plant Breeding Abstracts*, issued quarterly from Cambridge.
4. *Herbage Abstracts*, issued quarterly from Aberystwyth.
5. *Horticultural Abstracts*, issued quarterly from East Malling.
6. *Bulletin on Animal Genetics*, issued quarterly from Edinburgh.
7. *Nutrition Abstracts and Reviews*, issued quarterly from Aberdeen.

Abstracts on Agricultural Parasitology prepared by the Bureau at St. Albans appear by special arrangement in the *Quarterly Journal of Helminthology*, the Bureau obtaining reprints; in addition, that Bureau compiles and issues each year a list of the titles and sources of all papers appearing during the year on helminthology.

Each bureau has thus in its own field tackled the problem of providing research workers in the Empire with means of keeping informed and abreast of the developments throughout the world in their own subjects. Taken as a whole, the group covers a large part of the subjects which interest agricultural and veterinary workers. The successful issue of these abstracts, &c., marks a stage in the services which the bureaux are rendering to research workers in the Empire. In addition, satisfactory progress has been made in promoting contacts between research workers in the Empire, in collecting information on the various lines of research in progress in the Empire, in dealing with special inquiries, and in issuing bibliographies and reviews on subjects of special interest.

The Australian Dairy Cattle Research Association.

The Council for Scientific and Industrial Research is warmly supporting the action of a number of breeders of pure-bred dairy cattle, under the leadership of Dr. R. M. Kinross, of Sydney, in creating an Australian Dairy Cattle Research Association. In certain of the States, Branch Committees have been formed by the Association, and a Federal Council composed of delegates nominated by these State Committees has been set up with head-quarters in Sydney. The first meeting was held on 13th April.

The main object of the Association is to provide means to enable scientific investigations to be undertaken into the principal diseases affecting dairy herds in Australia. The two outstanding troubles are contagious abortion (Bang's disease) and contagious mastitis or mammitis. The Australian Dairy Council has shown its interest in the scheme by promising to provide £2,000 per annum for five years towards its estimated cost. The Directors of the Commonwealth Bank have voted a similar sum for two years from the Rural Credits Development Fund; while the Primary Producers Union of New South Wales has promised £100 per annum, with the probability that the sum will be increased later.

As a first step, co-operative arrangements have been made between the Research Association and the New South Wales Department of Agriculture for a thorough investigation into contagious abortion to be conducted at the Veterinary Research Institute at Glenfield. The State Department will provide certain facilities and staff, while further expenses, to an estimated total of £1,550 per annum, will be met by the Association. It is proposed that work on contagious mammitis shall be centred in Victoria, and a scheme drawn up by a special committee of the Australian Veterinary Association, and involving an expenditure of approximately £4,500 per annum for a period of years, has been approved by the Federal Council. It will not, however, be put into effect until the requisite money is in sight. The Victorian Department of Agriculture, the University of Melbourne, and the Council of Scientific and Industrial Research will all co-operate with the Australian Dairy Cattle Research Association in the mammitis work.

For the time being, the Research Association will limit itself to active participation in these two investigations, but later it hopes to extend its activities into other fields, particularly the investigation of tick fever and pleuro-pneumonia, in close association with the Animal Health Research Station at Townsville.

Electrical Moisture Meters for Timber—Third Series of Correction Figures.

In Trade Circular No. 9 of the Division of Forest Products, descriptions were given of different types of electrical moisture meters. At the present time, the most common type of these instruments in Australia is the " blinker sorter," and appended to the Trade Circular was a table showing the corrections necessary when using such an instrument on timbers other than that for which it has been set. Similar figures for other species were obtained later, and these were published in the *Journal of the Council for Scientific and Industrial Research,* November, 1932, as a second appendix (Division of Forest Products, Reprint No. 9) to the Trade Circular. Further tests on still different species have now added to this information. The first of the following two tables contains correction figures of a similar nature to those previously published.

Recently, a number of multi-reading blinkers have been placed in commercial use, and it is evident that, despite these being somewhat more expensive, there is a demand for them in addition to the sorter type of instrument. To enable the multi-reading blinker to be used on different Australian species, correction figures are being determined over the full range of moisture contents covered by these instruments. The results so far obtained are given in the second of the two following tables. It is advised that these two tables should be inserted after Appendices I. and II. in Trade Circular No. 9.

Appendix III. (Trade Circular No. 9).

Corrections Used with Blinker Sorters for Different Species of Timber.

For moisture contents in the neighbourhood of 12 to 15 per cent.

Species.		
Botanical Name.	Common Name.	—
Doryphora sassafras	New South Wales sassafras ..	0
Endiandra sp.	Maplum	0
Eucalyptus rostrata	Red gum	+2
Schizomeria ovata	Crabapple	+1
Sloanea woollsii	Yellow bean	+1

Corrections used with Multi-point Electrical Moisture Meters for different Species of Timber.

Meter Reading—Per Cent. Moisture		7	8	9	10	11	12	13	14	15
Species.	Common Name.	Correction.								
Pseudotsuga taxifolia ..	Douglas fir ..	0	0	0	0	0	0	0	0	0
Acacia melanoxylon ..	Blackwood ..	+3	+3	+3	+2½	+2½	+2	+2	+1½	+1
Endiandra palmerstoni ..	Queensland walnut	−2	−2	−1½	−1½	−1	− ½	− ½	+ ½	+1
Eucalyptus diversicolor ..	Karri	+1	+1	+1	+1	+ ½	+ ½	+ ½	0	− ½
Eucalyptus marginata ..	Jarrah	+ ½	+ ½	+ ½	+ ½	+ ½	+ 1	+1	+1	+1½
Eucalyptus obliqua ..	Messmate ..	0	0	0	0	0	0	0	+ ½	+ ½
Eucalyptus regnans ..	Mountain ash ..	+1	+1	+1	+1	+1	+1	+1½	+1½	+1½
Eucalyptus rostrata ..	Red gum ..	+2	+2	+2	+2	+2	+2	+2	+2	+2
Nothofagus cunninghamii	Myrtle (red) ..	+2	+2	+2	+2	+2	+2	+1½	+1½	+1½
	Myrtle (white) ..	+1½	+1½	+1½	+1	+1	+1	+ ½	+ ½	+ ½

Meter Reading—Per Cent. Moisture ..		16	17	18	19	20	21	22	23	24
Species.	Common Name.	Correction.								
Pseudotsuga taxifolia ..	Douglas fir ..	0	0	0	0	0	0	0	0	0
Acacia melanoxylon ..	Blackwood ..	+1	+ ½	0	− ½	− ½	−1	−1	−1½	−1½
Endiandra palmerstoni ..	Queensland walnut	+1½	+2½	+3	+3½	+4	+4	+4½	..	..
Eucalyptus diversicolor ..	Karri	− ½	−1	−1	−1½	−1½	−1½	−1½	+1½	−1½
Eucalyptus marginata ..	Jarrah	+1½	+1½	+1½	+2	+2	+2	+2	+2	+2
Eucalyptus obliqua ..	Messmate ..	+ ½	+1	+1	+1½	+1½	+1½	+1½	+2	+2
Eucalyptus regnans ..	Mountain ash ..	+1½	+1½	+2	+2	+2	+2	+2	+2	+2
Eucalyptus rostrata ..	Red gum ..	+2	+2	+2	+2	+2	+2	+2	+2	+2
Nothofagus cunninghamii	Myrtle (red) ..	+1½	+1	+1	+ ½	+ ½	0	− ½	− ½	−1
	Myrtle (white) ..	0	0	− ½	− ½	−1	−1½	−1½	−2	−2½

Recent Publications of the Council.

Since the last issue of this *Journal,* the following Bulletins and Pamphlets of the Council have been published:—

Bulletin No. 72.—"Varieties of Wheat in Australia: A Catalogue with Pedigree or Source, and a Genealogical Chart showing the Relationships of the more Important Varieties," by J. R. A. McMillan, M.Sc.

The writer of this Bulletin is the Senior Plant Geneticist of the Division of Plant Industry. In 1929, when, in pursuance of the programme of investigations of the Division, plans were being prepared as to the wheat crosses which should be made in order to study the mode of inheritance of certain characteristics, it was realized that it was very desirable to have, in a readily available form, the pedigree of each variety of wheat that had been grown in Australia. Accordingly, all available literature was searched and the information therefrom compiled. The compilation was then sent to the State Departments of Agriculture, with a request that they examine it critically, correct any errors, and add any further information available. This they did, and the value of the catalogue has accordingly been considerably enhanced. The pedigree of some 1,000 varieties of wheat have been given, and a genealogical chart of common Australian wheats is included as a folder at the back.

Bulletin No. 73.—"A Soil Survey of the Nyah, Tresco, Tresco West, Kangaroo Lake (Vic.), and Goodnight, N.S.W.) Settlements," by J. K. Taylor, B.A., M.Sc., F. Penman, M.Sc., T. J. Marshall, B.Sc.(Agr.), and G. W. Leeper, M.Sc.

The Bulletin gives the results of soil surveys that have been carried out on five settlements in the region of the Murray Valley, aggregating 9,300 acres, mainly planted to horticultural crops. Considerable decreases in cropped areas have recently occurred on one settlement (Tresco), and a proportion of each has been rendered unproductive by an excessive increase in soil salinity. Six soils belonging to five types have been defined. The soil position on the settlements has been outlined, mentioning the distribution and extent of the several soils, irrigation and drainage necessities, the importance of soil salinity, and its sphere of influence on each area. A general discussion of the problems connected with the soils of the areas is also given from the aspects of horticultural development, climatic influence on crops, improvements of soils and possible increase in yield, irrigation and drainage requirements, and soil salinity.

Pamphlet No. 37.—"The Sheep Blowfly Problem in Australia," Report No. 1, by the Joint Blowfly Committee.

This comprehensive report of 136 pages plus plates was briefly reviewed on page 62 of the previous issue. Copies are obtainable (price 1s. 6d., post free) on application to the Council or to the New South Wales Department of Agriculture.

Forthcoming Publications of the Council.

At the present time, the following future publications of the Council are in the press:—

Bulletin No. .—"Observations on Soil Moisture and Water Tables in an Irrigated Soil at Griffith, New South Wales," by E. S. West, B.Sc., M.S.

Pamphlet No. .—"The Occurrence of *Anaplasma marginale* Theiler 1910, in Northern Queensland," by J. Legg, D.V.Sc.

Pamphlet No. .—"The Grading of Western Australian Timbers: Report on, and Suggested Specifications for, the Grading of Jarrah and Karri based on Investigations in 1932," by F. Gregson, B.E., and R. F. Turnbull, B.E.

Pamphlet No. .—"Meteorological Data for Various Localities in Australia" (in co-operation with the Commonwealth Weather Bureau).

In addition, the typescripts of future publications dealing with the buffalo-fly, squirter in bananas, and lucerne flea are approaching completion.

H. J. Green,
Govt. Printer, Melbourne.